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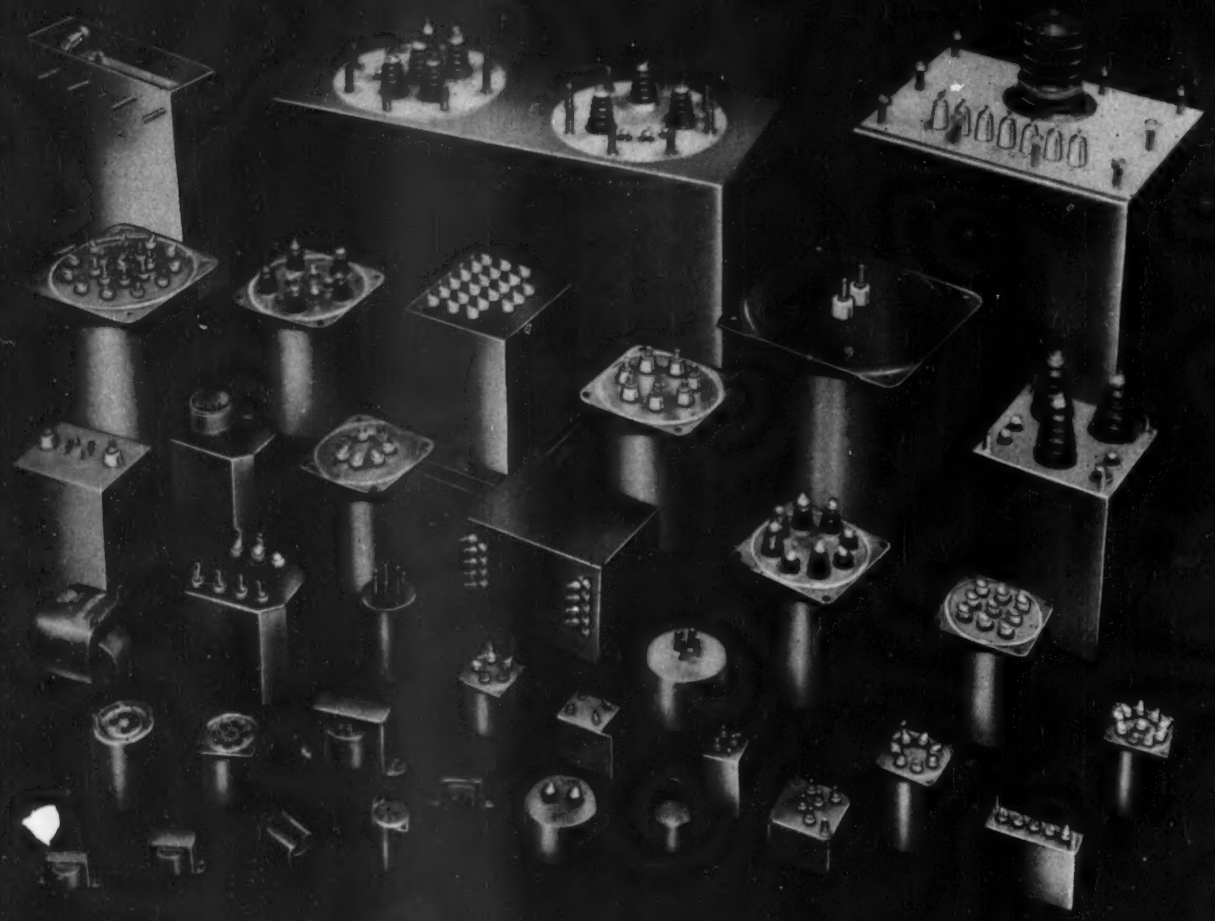
TESTING
40-MEGAWATT
HYDROGEN
THYRATRON

for MILITARY COMPONENTS



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TESTING 40-MEGAWATT HYDROGEN THYRATRON—Designed for pulsing radar magnetrons, a VC 1257 hydrogen thyratron undergoes tests at Chatham Electronics, Newark, N. J. Stem contains hydrogen generator and hot filament arrangement to maintain gas pressure (see p 158) ..... *COVER*

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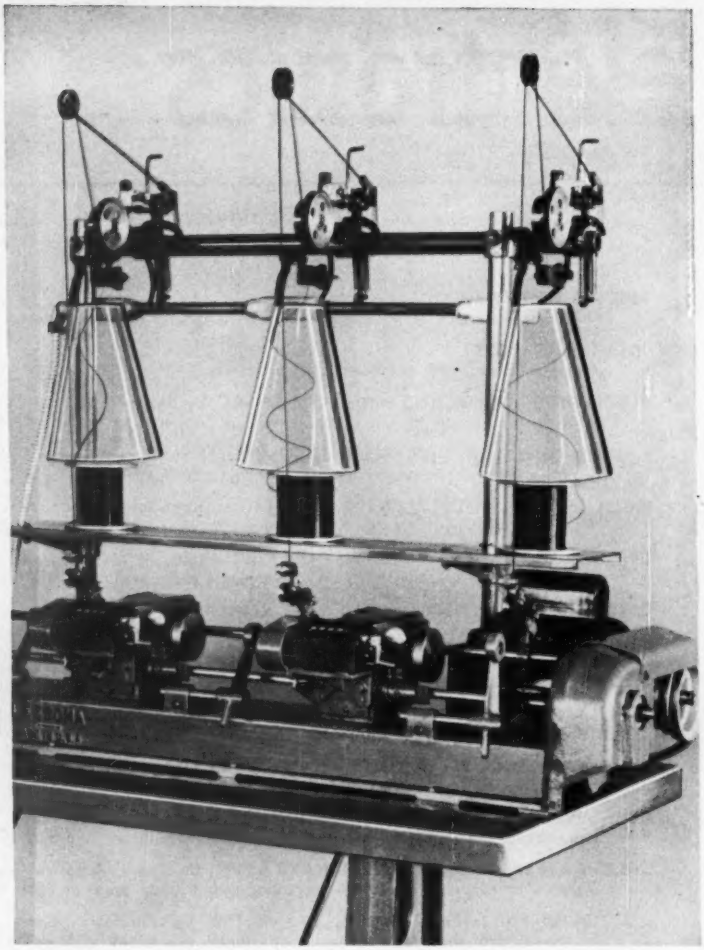

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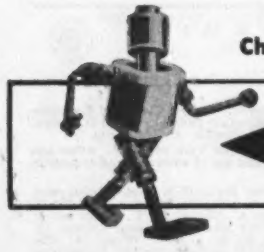

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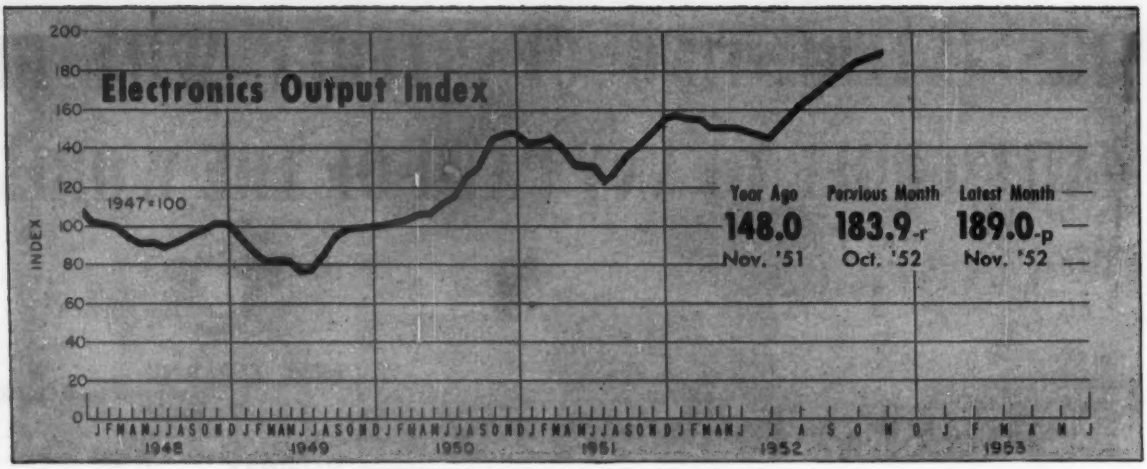


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Nov. '51	Oct. '52	Nov. '52
Television sets	415,332	724,117	780,486-p
Home sets	477,734	314,459	389,853-p
Clock Radios	———	180,841	185,639-p
Portable sets	64,111	113,552	153,503-p
Auto sets	206,069	163,494	195,200-p

RECEIVER SALES

(Source: RTMA)		Oct. '52	Nov. '52
Television sets, units	———	847,219	803,327
Radio sets (except auto)	———	580,077	486,800

RECEIVING TUBE SALES

(Source: RTMA)	Nov. '51	Oct. '52	Nov. '52
Receiv. tubes, total units	32,710,369	41,880,318	36,942,664
Receiving tubes, new sets	20,405,712	29,132,068	25,898,849
Rec. tubes, replacement	8,539,275	8,791,404	8,568,037
Receiving tubes, gov't.	1,371,886	3,105,005	1,712,080
Receiving tubes, export	2,393,496	851,841	763,698
Picture tubes, to mfrs.	460,566	862,431	754,060

BROADCAST STATIONS

(Source: FCC)	Dec. '51	Nov. '52	Dec. '52
TV Stations on Air	108	116	129
TV Stns CPs—not on air	0	114	144
TV Stns—Applications	475	836	812
AM Stations on Air	2,331	2,374	2,391
AM Stns CPs—not on air	77	139	133
AM Stns—Applications	304	250	251
FM Stations on Air	637	626	616
FM Stns CPs—not on air	13	14	14
FM Stns—Applications	8	9	12

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Nov. '51	Oct. '52	Nov. '52
Aeronautical	31,415	33,630	34,187
Marine	33,700	37,914	38,166
Police, fire, etc.	9,969	11,772	11,956
Industrial	11,233	15,090	15,347
Land Transportation	5,362	5,346	5,427
Amateur	99,292	116,102	117,069
Citizens Radio	674	1,788	1,803
Disaster	28	80	87
Experimental	452	519	503
Common carrier	835	1,032	1,020

TV AUDIENCE

(Source: NBC Research Dept.)	Dec. '51	Nov. '52	Dec. '52
Sets in Use—total	15,176,200	19,751,200	20,439,400
Sets in Use—netw'k conn.	14,363,700	19,720,900	20,408,500
Sets in Use—New York	2,720,000	3,180,000	3,230,000
Sets in Use—Los Angeles	1,065,000	1,270,000	1,320,000
Sets in Use—Chicago	1,060,000	1,290,000	1,325,000

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	Nov. '51	Oct. '52	Nov. '52
AM/FM—ABC	$3,220,760	$2,887,571	$2,612,761
AM/FM—CBS	$5,257,454	$5,817,930	$5,419,533
AM/FM—MBS	$1,583,291	$2,304,804	$2,172,485
AM/FM—NBC	$4,315,646	$4,230,576	$4,073,971
TV—ABC	$1,911,243	$1,453,811	$1,368,552
TV—CBS	$4,605,506	$6,754,231	$6,525,176
TV—DuMont	$847,373	$995,376	$1,026,566
TV—NBC	$6,535,907	$7,805,668	$7,957,417

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Oct. '51	Sept. '52	Oct. '52
Prod. workers, electronic	257,500	297,100-r	307,100-p
Av. wkly. earnings, elect.	$63.87	$66.90-r	$67.80-p
Av. wkly. earnings, radio	$60.41	$63.24-r	$63.45-p
Av. weekly hours, elect.	41.5	41.5	41.8-p
Av. weekly hours, radio	40.9	41.2	41.2-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Dec. '51	Nov. '52	Dec. '52
Radio—TV & Electronics	265.6	321.9	322.7
Radio Broadcasters	252.6	300.3	304.4

INDUSTRIAL EQUIPMENT ORDERS

(Source: NEMA)	Quarterly Figures: Year Ago	Previous Quarter	Latest Quarter
	3rd '51	2nd '52	3rd '52
Dielectric Heating	$210,000	$510,000	$320,000
Induction Heating	$4,060,000	$2,410,000	$1,760,000
Welding Control	$1,280,000	$1,480,000	$1,810,000
Other Electronic Control	$720,000	$1,020,000	$920,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	3rd '51	2nd '52	3rd '52
Vacuum (non-receiving)	$8,420,000	$12,110,000	$10,580,000
Gas or vapor	$2,620,000	$3,150,000	$2,950,000
Phototubes	$270,000	$480,000	$570,000
Magnetrons and velocity modulation tubes	$3,740,000	$9,830,000	$8,500,000

p—provisional; r—revised; e—estimated

INDUSTRY REPORT

TV Manufacturers Get Set For 1953

New models are introduced as companies forecast banner sales for this year

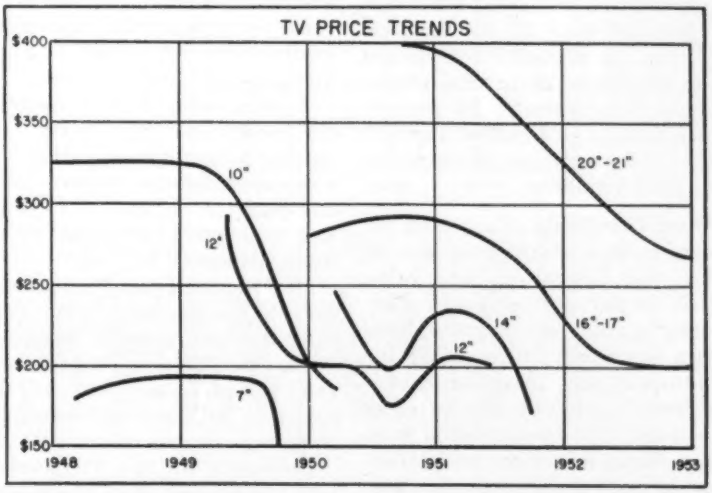
CHRISTMAS rush for tv sets was hardly over before the television receiver industry began introducing new tv sets for 1953 and predicting top sales for the new year. Nearly every set manufacturer introduced new tv models during January. Many of them displayed complete new lines of as many as 30 sets. Radios were also in the limelight as industry leaders predicted that nearly 8 million would be sold this year.

▶ **One Line**—Many tv receiver manufacturers endorse the idea of one line a year and carried 1952 sets into 1953. Manufacturers such as Admiral, DuMont and GE added only a few new models to their 1952 receivers at January showings. Some manufacturers brought out complete new lines however. They feel that it will be some time before the industry as a whole is able to give the one-line-a-year policy a real try. They believe that too many new developments are still in the making, that these could not be held back even if sales were at a peak.

▶ **New Sets**—Actually, new merchandise introduced last month was not far different from 1952 receivers. Prices were pretty much in line with last year's. Some were a little higher and some lower. More 21-inch and 27-inch sets were displayed and fewer high-priced radio-tv-phonograph combinations were in the lines. Provisions for uhf were stressed and new uhf tuners and converters were introduced. Most major tv manufacturers incorporated built-in uhf-vhf antennas in their sets.

▶ **Predictions**—With 1953 merchandise ready to roll, leading manufacturers looked at the year ahead and came up with a highly optimistic picture. They saw from 75 to 200 new tv stations coming on the air in 1953, bringing tv entertainment to 5 million more families and tv sales of at least 1.5 million sets in these new markets alone.

Gains were also predicted for replacement and second-set sales. It was estimated that nearly half of the sets now in use have screens smaller than 16 inches in size and that more than 4 million sets are at least 3 years old. Total production of at least 6 million receivers was expected by most manufacturers. Many predicted that the tv industry would reach a going rate of $6 billion in 1953.



History of television in United States is portrayed dramatically by these curves, showing how average list price of cheapest table model television receiver (with each picture tube size) varied during growing years of new industry. As prices tobogganed, smaller-size screens were dropped one by one

Transistors Replace Hearing Aid Tubes

Users pay extra for units but save on a much lower annual battery cost

ANNOUNCEMENTS of transistorized hearing aids have been coming in thick and fast in the past few weeks. This comes as no surprise, because of the transistor's inherent high efficiency and ability to operate at low voltages.

First to show a working model was Sonotone, with a 3-oz. unit using two subsubminiature tubes and a junction-transistor output stage. Tubes are used in the input and driver stages because of their low noise characteristics. With

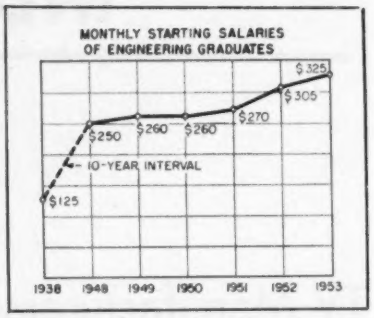
this design a B battery is still required, but B-battery drain has been cut more than 80 percent by the transistorized output circuit.

Other hearing aid manufacturers, some of whom are oldtimers in the business, and some of whom are new, are coming up with all-transistor amplifiers completely eliminating the need for a B battery. Maico has a three-transistor unit "on the market", and Acousticon has one ready to go. Most popular transistor appears to be Raytheon's CK718, which is similar to their mass-produced CK721.

▶ **Market**—A vivid picture of the potential market for hearing aids was painted by Sonotone president Irving Schachtel, who said "Today in America, 15 million people have hearing deficiencies, and 3 to 5 million need some sort of hearing aid to get along in the social and business worlds. Of these, only one million are now using hearing aids."

Prices for transistorized hearing aids range anywhere from $75 to $250 and more. At the higher price this figures to be around $75 an ounce.

This evaluation makes transistor hearing aids considerably more valuable than their equivalent weight in just about anything we can think of.



Survey of 176 industrial concerns by Northwestern University shows the steady rise in salaries for engineers just out of college. Of the companies, 69 thought salaries were too high, 97 thought they were in line, 10 didn't answer.

Combatting Shortages of Engineers

Trends include farming out routine engineering work, deferring retirements

TO EASE the strain on their engineering staffs, 55 percent of the electronic manufacturing firms responding to a recent survey are farming out some of their work to engineering consulting firms; 31 percent of these companies use drafting contract firms, 26 percent use research organizations, 20 percent use retired engineers and 9.8 percent use non-citizen engineers.

▶ **Consultants**—The job-shop type of engineering consultant firm performs the complete engineering job of translating a manufacturer's idea or rough design into a finished package ready for the production line. In contrast, the service-type of consulting firm sells man-hours of engineers who work closely with the manufacturer's engineers. The chief drawbacks noted here are that premium rates are sometimes charged for scarce engineering talent, and the outside consultants "take too much of our own engineers' time".

▶ **Retired Engineers**—Where retirements are being deferred to keep engineers on the job longer, a less strenuous work schedule is usually provided. Engineers eligible for retirement may thus come in four days a week the first year, three days a week the next year, two days a week the next, and then on a limited one-day or several-hour schedule or purely on a consulting basis. Use of retired engineers depends greatly on the individual's ability, physical and mental condition.

Relaxation of hiring standards is helping, too. Of the firms reporting, 26 percent have relaxed age standards, 28 percent educational requirements, 39 percent requirements in experience and 19 percent have relaxed standards on physical condition.

▶ **Part-Time Profs**—To a lesser extent, college engineering professors and instructors are being used for part-time jobs and counseling work. This has the long-term advantage of providing the additional pay incentive needed to encourage graduates to enter teaching. For the academic year, the average salary for an instructor is only $3,151 and for professors $5,980. Starting salaries in the teaching professions average about $250 a month, which is well below that offered by private industry.

▶ **Source of Figures**—*How to Improve The Utilization Of Engineering Manpower*, a 56-page report prepared by the National Society of Professional Engineers, 1121 15th Street N. W., Washington 5, D. C. and available from the society at $2 a copy.

Army And Navy Call For Increased Output

ARMY and Navy procurement officials are urging electronic contractors to step up production because fiscal year 1951 funds, made available in July, 1950, will expire June 30, 1953.

A large percentage of electronics equipment for Army and Navy is bought with so-called "one year appropriations" that allow one year to obligate the money and two years to spend it for items delivered.

Of the total funds available for electronics, only about one third has been spent to date. Air Force officials claim that this is a good record considering that the lead time has been approximately 24 months, is now about 20.

Deliveries of Air Force electronic equipment since Korea have multiplied about ten times, as compared to over-all military elec-

(Continued on page 8)

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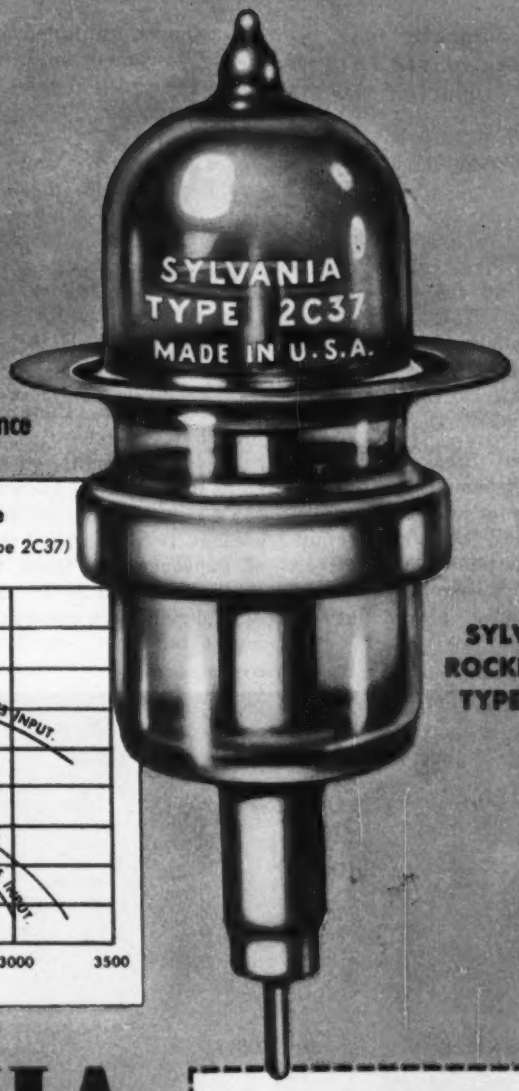
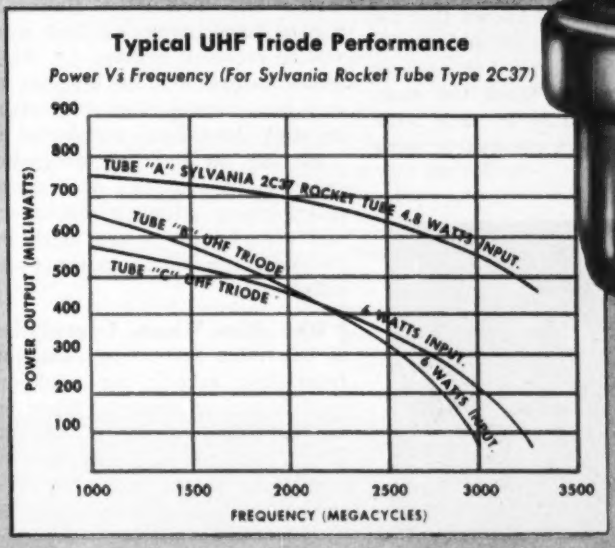
Because of their high power throughout the UHF spectrum, Sylvania rocket tubes are especially recommended for service as pulsed oscillators, cw oscillators, rf amplifiers and frequency multipliers... this is one more reason why it will pay you to specify SYLVANIA.



SYLVANIA ROCKET TUBE TYPE 2C37

Compare Sylvania Rocket Tube's Performance



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tronics which have multiplied approximately 8 times. No dip or stretch out is anticipated in electronic items for the next two years.

If contractors do not get payments from the U. S. before June 30, there is likely to be considerable delay in getting settlements. Money not expended returns to treasury.

Bing's Mirror To Reflect in December

Device for magnetic tape recording of video signals is readied for production

BING CROSBY money has helped develop the machines used for all types of commercial sound recording work.

Not content with being able to hear himself sing, Crosby apparently wants to see himself act on television. The only mirror presently available is the kinerecording, in effect a special motion picture made from the images on a picture tube.

▶**Cutting Out Steps**—Engineers have long dreamed of putting video signals on magnetic tape to be played back through the equivalent of a television receiver rather than a movie projector. The same tapes, played into a television transmitter, would eliminate the camera and film projector for recorded shows.

Until recently, it has been possible to record frequencies only up to the limit of normal human hearing (around 15,000 cycles). This requires a tape speed of 15 inches a second. To record television signals with a frequency range up to about 4,000,000 cycles, Crosby's engineer John T. Mullin had to speed his tape up to 100 inches a second.

▶**Splitting the Picture?** — Although technical information has been frozen for the next six or eight months, it is known that today's tape pictures are inferior to present tv programs but capable of improvement. Since the magnetic tape used is an inch wide (sound recorders use quarter-inch tape) engineers think the Crosby technique is to split up the picture frequencies and record strips of frequencies separately but simultaneously, combining them in the reproducing equipment. Half-inch tape will be used in the next prototype model.

Production models are promised in November or December at about $60,000.

Der Bingle, electronic gadgets (background), magnetic tape recorder and friend represent the essentials of a recorded video program. Tape cost is estimated at $80 a half hour as against $150 for kinescope film

RTMA Picks Up Ball On TV Interference

Manufacturers set up task committees for receivers, transmitters and coordination

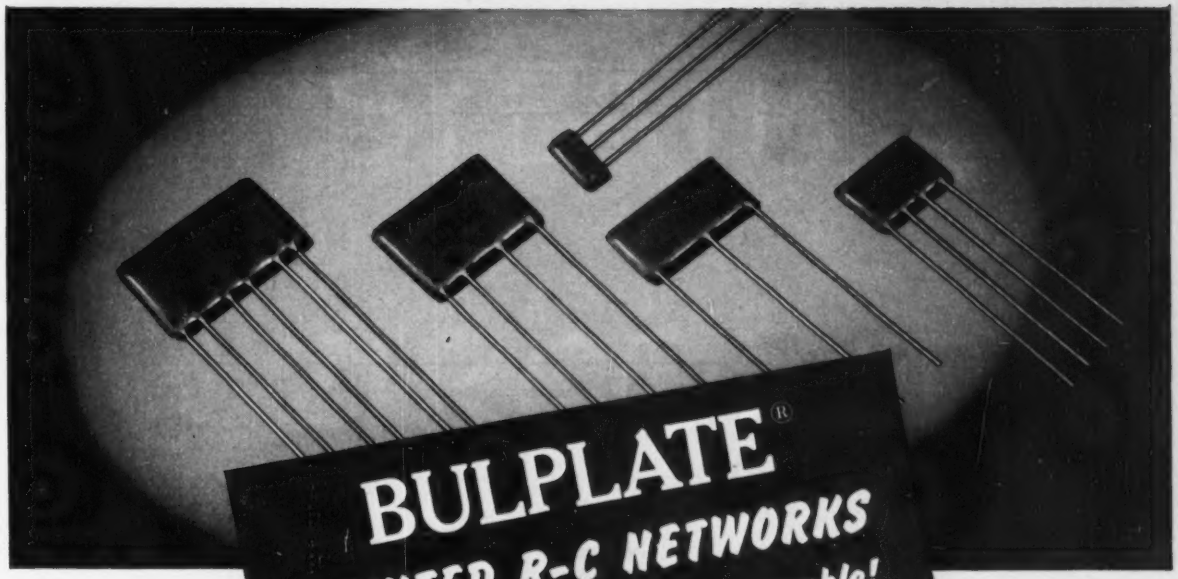
AT a recent meeting in New York City, W. R. G. Baker, director of the engineering department of the Radio and Television Manufacturers Association, advised television receiver makers to clean house before FCC is tempted to step into control of their product through back-door legislation.

By far the bulk of discussion centered on problems of receiver interference, although machinery was also set up to deal with infrequent transmitter spurious signals.

▶**Who Hits Whom**—Degradation of television service by radiation from other sets in the neighborhood is serious enough. When local oscillator signals leak out strong enough and far enough to distort VOR airport navigation (as has happened) FCC begins to have legal grounds for requesting that each receiver come under its jurisdiction.

Although RTMA has set up certain standards that should improve reception and limit radiation, these are presently more often honored in the breach than in the observance. Among them is a recommendation for an intermediate frequency of 41.25 mc (ELECTRONICS, p 22, Jan. 1953). But some manufacturers have had

(Continued on page 10)



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Printed circuits like those shown here offer important advantages in radio and TV production—fewer parts to purchase, inspect, handle, and stock; fewer soldering operations and quicker assembly with minimal wiring errors; faster and easier inspection; greater compactness; and lighter weight. And usually they cost less than the individual capacitors and resistors they replace!

BULPLATE Printed Circuits are a logical outgrowth of Sprague-Herlec BULPLATE Multiple Ceramic Capacitors, first to use the active dielectric as a supporting medium for printed wiring. The printed resistor elements of these plates have proved to be highly stable, another important Sprague contribution.

Thousands of BULPLATES are now in use in radio, television, and military electronics. Are you overlooking a winning bet for your production?

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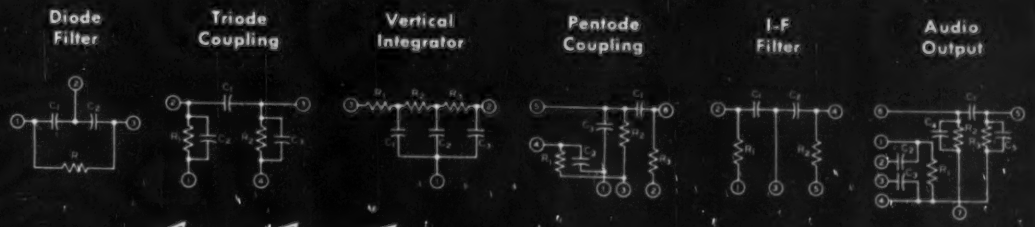
TYPICAL RADIO AND TV BULPLATE CIRCUITS



SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

to ship out relatively expensive wave traps because of interference from land mobile two-way radio systems operating near this frequency.

▶**Committee Plans**—Working in cooperation with the Joint Technical Advisory Committee (which includes the Institute of Radio Engineers) RTMA has appointed a committee on receivers charged with responsibility for limiting oscillator radiation and establishing target dates. Another group will perform a similar function in the transmitter field. A third committee will coordinate the work of the other task groups and keep them in touch with JTAC, IRE and FCC.

One practical stumbling block for both receiver and transmitter control is lack of inexpensive measurement equipment, particularly for the new uhf channels.

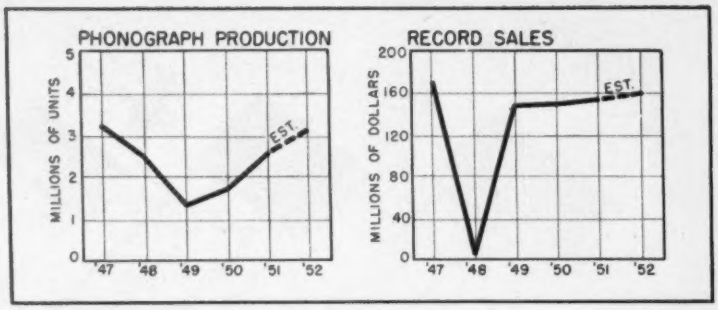
Small Fields Lighted By Pilots in Flight

Radio-controlled field lights are turned on by pilot as plane approaches airport

PILOTS who are forced to make emergency landings in small airports at night do so at extreme risk because most small fields are unlighted and unattended during hours of darkness.

An electronic system for making these fields safe for night use is now being used at Kingman, Arizona in connection with operation of the Bonanza Airlines. A pilot may turn on the field lights by pressing the 'talk' button of his regular vhf transmitter three times at half-second intervals from as far as 100 miles from the field. Lights are turned off by five similarly-transmitted signals.

Bonanza's radio-controlled lighting system is being studied for possible application to other commercial runs, and suggestions have been handed the CAA that a special frequency be set aside for controlling field lights.



TURNTABLE output and disk sales increase as . . .

Phonograph Field Makes New Gains

Volume climbed to 5-year peak in 1952; further increases are expected this year

RECORD PLAYERS and records are continuing to grow as an important segment of the electronics industry. Although phonograph and record statistics vary with the source, all figures indicate a rising sales trend, as shown in the charts.

Indications are that production of phonographs and sales of phonograph records in 1952 reached the highest point since 1947. It is estimated that between 3 and 4 million phonographs were produced last year and that the dollar volume of records was between $157 and $200 million. Continued growth for both products is forecast for 1953.

▶**Phonographs**—The total number of turntables in use in the U. S. has risen steadily since the war from an estimated 12 million in 1947 to about 26 million at the end of 1952. Of nearly 22 million phonos in use at the end of 1951, about 8 million were capable of playing 45-rpm records and 7 million could be used for 33⅓-rpm records.

Despite the increased production of phonographs, fewer of them are being sold in tv and radio receivers. Only 10 percent of all tv models now on the market are equipped with phonographs and even less have a phonojack. According to RTMA figures, the percentage of tv sets produced with phonographs dropped from 14.1 percent in 1947 to 6.2 percent in 1951. Fewer radio sets incorporate phonographs. In 1950, 277,100 table-model radio-phonographs were produced as against 235,177 in 1951. Console radio-phonographs declined from 844,100 in 1950 to 463,713 in 1951. New lines just introduced are continuing the trend but sales of self-contained phonographs are evidently more than able to take up the slack.

▶**Records**—Phonograph record sales have increased along with turntable output since 1947. With the exception of 1948 when a musicians' work stoppage occurred, dollar volume of records has climbed steadily even with disruptions caused by the introduction of new speeds. Final figures for 1952 are expected to show that more than 170 million U. S. records of all speeds and types were produced, representing over $160 million in retail sales.

Breakdown of record sales in 1952 is expected to show a continuation of the sales trend toward the 45-rpm and 33⅓-rpm record speeds. In 1949 the percentage of total sales accounted for by each speed was: 78 rpm, 88 percent; 33⅓ rpm, 8 percent; 45 rpm, 4 percent. In 1951 the percentages were: 78 rpm, 66 percent; 33⅓ rpm, 16 percent; 45 rpm, 18 percent.

▶**Future**—Phonograph manufacturers who were hindered by a

(Continued on page 14)

STEATITE

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What do these names mean to you?

These Centralab Engineered Ceramics solve electronic and industrial production problems . . . hold premise of wonders to come!

FOR MORE INFORMATION ON HOW THESE CENTRALAB ENGINEERED CERAMICS CAN OFFER YOU BIG SAVINGS, SEE NEXT TWO PAGES

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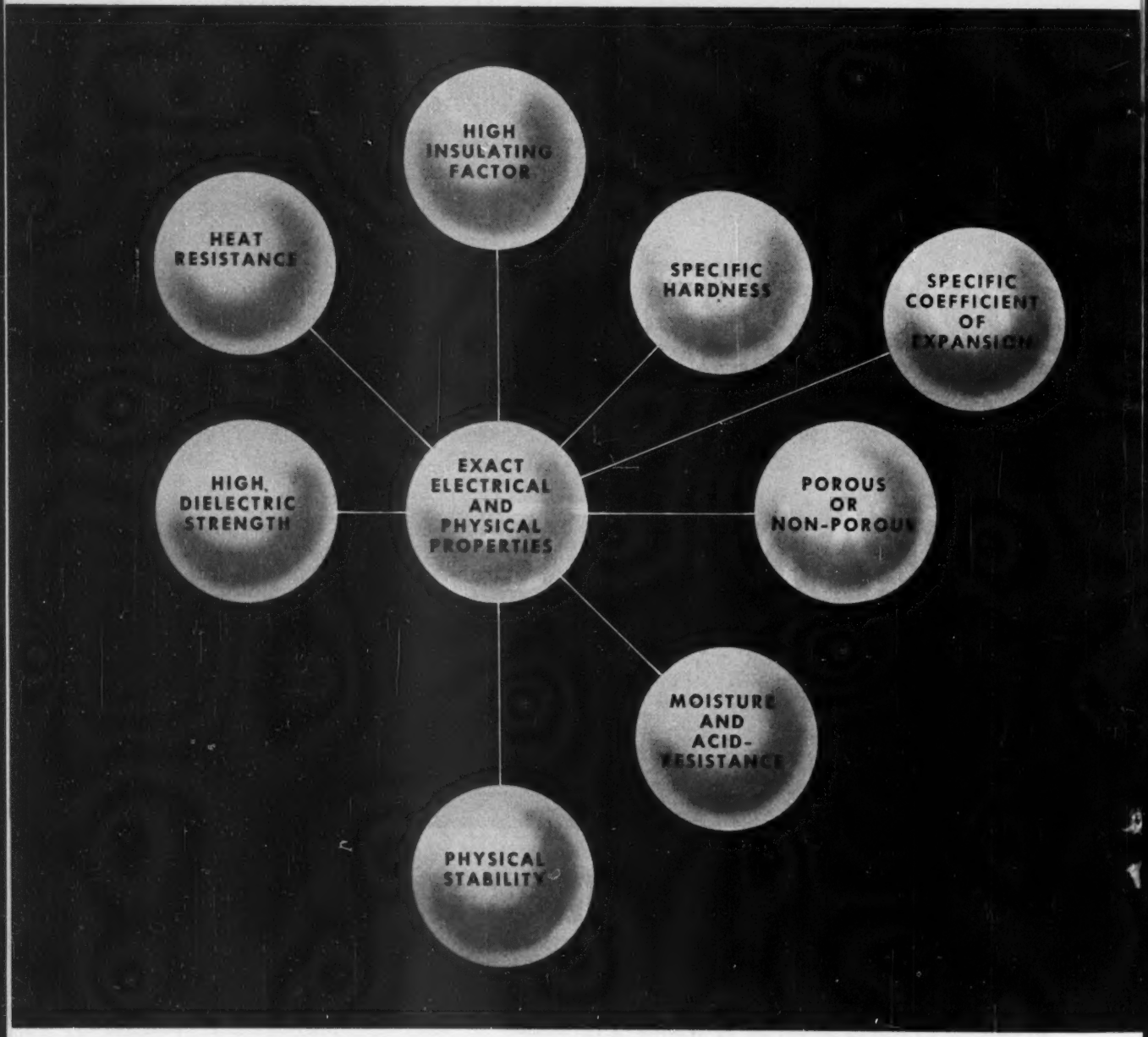
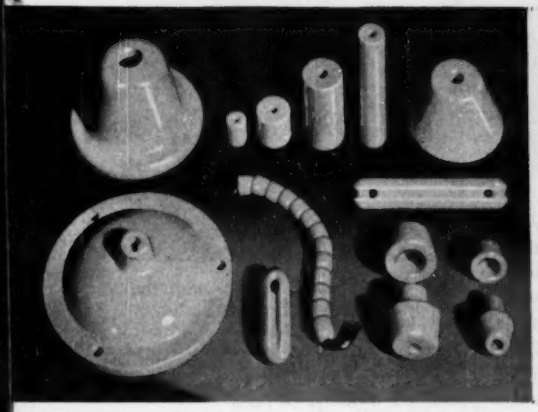


THERE'S a Centralab Ceramic material to match your individual requirements — electrically . . . physically . . . structurally. These materials are unique. We can extrude, mold or press them. What's more, Centralab Ceramics can be worked the same as metal—drilled, turned, ground or tapped. In addition, they can be metalized. Every Centralab Ceramic has some of the properties shown above, and they meet all JAN-I-8 and JAN-I-10 specifications, without exception.

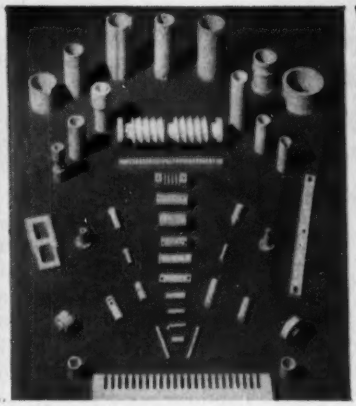
Centralab is the leader in ceramic development — making fine ceramics since 1928. Metalized ceramic material for close tolerance application was a CRL first. We have a complete staff of engineers, physicists and chemists ready to help you develop better product design through the use of Engineered Ceramics. Write for full technical details.

any of these properties, CRL Engineered Ceramics!

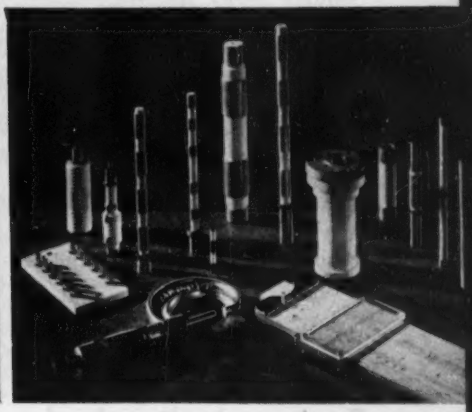
Here are examples of special Centralab Ceramics produced for structural, electrical and electronic use



Note the Standoffs illustrated, upper center. Made to government specifications, they are available commercially at a price lower than most standard units. Note the many types of specialty items.



Specialty items include forms for coils and various electronic components, such as variometer rotor and stator bars, heater coils, etc. Commercial units are available in Grade L-5 and L-6 Steatite if required.



Many different ferrous and non-ferrous metals can be applied to ceramic bodies, combining the desirable properties of the metal plus the dielectric strength and other unique properties of ceramics.

FULL Centralab design and production facilities are available to meet your exact need

Centralab engineers constantly improve CRL Ceramics searching for new materials . . . developing more economical production methods. Consult Centralab on your problems.

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lack of motors in 1952 due to sparse steel supplies feel that, with additional steel allocations by NPA, this year will be one of their best. Action of CBS who will soon begin selling a higher priced hi-fi phonograph, and Emerson, who takes over Webster-Chicago, seems to substantiate this forecast. It is also reported that Zenith will bring out a new hi-fi phonograph this year.

Record manufacturers see new volume highs for 1953 and are preparing for them. Through RIAA (Record Industry Association of America) they plan to run a test sales campaign and market survey to determine the long-range effect on record sales of increased sales of phonographs. The results of the test and survey may lead to changes in phonograph record advertising and promotion.

Top Management Reviews Its Paychecks

Higher net sales helped to up executive salaries but taxes and living costs also rose

COMPENSATION of principal executives in the radio and television industry increased substantially between 1949 and 1951, reflecting an even healthier increase in net sales for firms they represented. However, higher income taxes and rising costs tempered the effects of both, according to a study made by the National Industrial Conference Board of company reports to the Security and Exchange Commission.

▶ **Set Manufacturers**—The study shows that between 1949 and 1951 the net sales of 10 representative radio and television receiver manufacturers increased an average of 38 percent. In 1949 they ranged from $6.1 million to $396 million, while in 1951 the span was from $12 million to $599 million. For the same companies the total officers' payroll rose 24 percent during the period. Total executive payroll ranged between $57,000 and $1.6 million in 1949. In 1951 the range was between $93,000 and $2.1 million.

As a percentage of sales, top management salaries represented 0.5 percent of total net sales in 1949 and 0.6 percent in 1951. For individual set makers the percentage ranged from 0.4 percent to 1.4 percent in 1949 and from 0.3 percent to 1.2 percent in 1951.

▶ **Parts Manufacturers**—Management salaries also rose substantially in radio and television parts companies, according to the SEC report study. Between 1949 and 1951 the net sales of 8 leading parts manufacturers increased over 100 percent and total officer salaries during the three-year period rose 35 percent. In 1949 the net sales of these firms ranged from $600,000 to $15.5 million, while in 1951 the span was from $1 million to $33 million. Total pay to parts company officials ranged from $54,000 to $310,000 in 1951. The bracket was $11,000 to $70,000 in 1949.

Total executive salaries for the parts companies surveyed represented as a percentage of net sales 1.5 percent in 1949 and 1.6 percent in 1951. For individual parts companies, the percentage ranged from 0.7 percent to 5 percent in 1949 and from 0.7 percent to 5.4 percent in 1951.

▶ **Top Man**—The highest-paid executive in each of the radio and television set manufacturing firms surveyed received a salary in 1949 ranging from $18,800 to $200,000. The top salary of $200,000 didn't change in 1951 but the lowest salary reported increased to $25,000. Although bonus reports were incomplete, figures available indicate that they also increased substantially. A bonus high of $120,700 was reported in 1951. In 1949 the high was $49,300.

Among the radio and tv parts manufacturers surveyed the salary of the highest-paid executive in each of these firms ranged from $11,000 to $70,000 in 1949. In 1951 the spread was from $32,000 to $79,300. Executive bonus checks remained relatively stable.

▶ **Costs**—The average executive who earned $50,000 in 1949 had a net after taxes of $33,000. In 1951 his take-home-pay from the same amount was $31,100. The cost of living as measured by the Consumer's Price Index also had its effect. It stood at 161.3 in 1949 but by 1951 had risen to 174.5.

THE MAN says "three" and the proper light lights to show. . . .

Robot Responds To Spoken Numbers

Digits from 1 through 0 are made into patterns, matched with memory standards

AN EXPERIMENTAL UNIT in Bell Labs responds to spoken numbers by lighting the proper light for each digit from 1 to 0. The response is accurate when circuits are adjusted to the individual voice, if enunciation is clear. Signals could equally well perform other functions, such as operating dial mechanisms.

In this developmental stage the engineers are cautious, putting customer vocal dialing somewhere in the future. But they hope Audrey—the 'automatic digit recognizer'—can be taught to respond to additional sounds, perhaps even say a few words on command.

▶ **Audrey's Nerves**—Circuits and relays used in modern dial systems were used in the unit's construction. The voice sounds are sorted into electrical categories which conform to sound wave patterns.

(Continued on page 16)

SHOCK AND VIBRATION NEWS

Builder Claims Smooth Performance and Quiet Operation thru the use of Barrymounts in Dehydrator

The 2-way protection given by Barrymounts is applied in AUTO-DRYAIRE® dehydrators as a design feature of these automatic pressurizing units for high-frequency transmission lines.

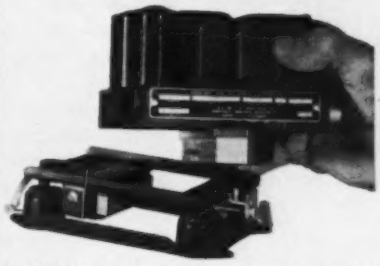
In this service, Type C-2000 Barrymounts prevent transmission of air-compressor vibration to the supporting surface. They also cushion the mounted apparatus to protect active parts, piping, and controls within the dehydrator from external shock and vibration.

The maker of AUTO-DRYAIRE®, Communication Products Company, Inc. of Marlboro, N. J., states: "We have used Barry Isolators for several years. The excellent service they have rendered in our equipment is the primary reason for their continued use."

Type 2000 Barrymount

Barry "cup" mounts are satisfying a wide variety of needs in industrial, mobile, and marine service. Ask our Field Engineering Department for help with YOUR vibration problems. FREE CATALOG 504-B tells about these and other vibration isolators.

Miniaturized Vibration Isolators Help Cut Space and Weight in Fuel-Gauge Power Unit



70% size reduction and 50% weight reduction — with no loss of performance — is the effective miniaturization obtained in the new Minneapolis-Honeywell aircraft-fuel-gauge power unit. Miniature, air-damped Barrymounts, Type 6465, helped M-H engineers in this achievement.

These vibration isolators, in which size and weight have been cut while operating characteristics have been maintained, will help you redesign for miniaturization.

Check these useful features of miniaturized Barrymounts.

Light weight — only 5/16 ounce each.

Small size — 1" diameter 11/32" loaded height.

Resonant frequency — 9 cps

Transmissibility at resonance — 3

Wide load range — 0.1-3 pounds

4 different styles available — for plate or stand-off mounting.

Write for data sheets 605 and 606 giving details of dimensions and load ratings.

FREE CATALOGS

- 523-A — Air-damped Barrymounts for aircraft service; also mounting bases and instrument mountings.
- 509-A — ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504-B — Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 — How to cut maintenance costs by using Barrymounts with punch presses.

THE BARRY CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

Want more information? Use post card on last page.

These categories are matched, in a memory cell, against electronically-drawn standard reference patterns. When the electrical pattern of the spoken number matches the standard pattern, the proper light flashes.

Voice-operated devices have been used for years in transoceanic telephony, but until now none of them have had to distinguish between different words. The key to Audrey's success is the visible study of speech patterns done in Bell Labs on the sound spectograph and similar machines.

Electronics Surplus Is Still Big Business

Obsolete and overstocked supplies continue to pour out of warehouses

FAR FROM PETERING OUT with dribbles of World War II equipment, the electronics surplus industry is growing, according to the Institute of Surplus Dealers, Inc.

At the recent surplus show in New York, Eugene P. Connolly, the Institute's president, guesstimated a $25,000,000 volume this year in surplus electronic gear. And Connolly thinks it will never end. Surplus, he says, is here to stay, a part of our economy and a pretty large part at that.

▶ **Organization**—The Institute has compiled a list of 2,200 dealers across the country, but there are many more not listed or disguised under other business operations.

A manufacturer looking for surplus supplies has two ways to go. He can watch the ads in publications and surplus dealers' circulars, or he can write to the Institute (673 Broadway, New York City). He may find what he wants but, if he doesn't, that is no sure indication the surplus goods are not there. Surplus dealers by and large aren't electronics men; they don't know a 6V6 from a megawatt.

Television Expands Overseas

Sets abroad top 2.4 million, 21 countries have service; Latin America best US market

TELEVISION is making significant progress abroad. Stations are on the air in 21 foreign countries and regular service is scheduled for seven more by the end of the year. Sets in use total 2.4 million, up 50 percent over 1951 figures. Ganging-up 10 or 15 people to a set is common and the viewing audience is estimated at 24,450,000.

Latin American countries have shown great interest in television and this area is potentially an important market for American manufacturers. Picture standards are in general the same as in U. S. Elsewhere, Japan has adopted our standards and is planning a tv network that may include 30 stations or more. However, fourteen Japanese-electronic firms reportedly are gearing up for mass production of tv receivers. Japan looms as a competitor rather than customer in the world market.

▶ **Cuba**—Fourth in number of sets in use, Cuba has complete television coverage. Two competitive networks cover the island and 100,000 sets are in use. Havana has two stations, with a third planned for 1953. Ten additional stations are planned.

▶ **Mexico**—Mexico, with five stations on the air, has only 40,000 sets in use. One major problem is the 50 and 60-cps power service in Mexico City. A heavy import duty on finished sets has been partially circumvented by shipping chassis to assembly plants in Mexico. Some manufacturers have considered making sets in Mexico for export elsewhere in Latin America to take advantage of the favorable tariffs between Mexico and other Latin American countries. Spain enjoys similar tariff advantages and this may be one reason why a large U. S. tv manufacturer will operate from there.

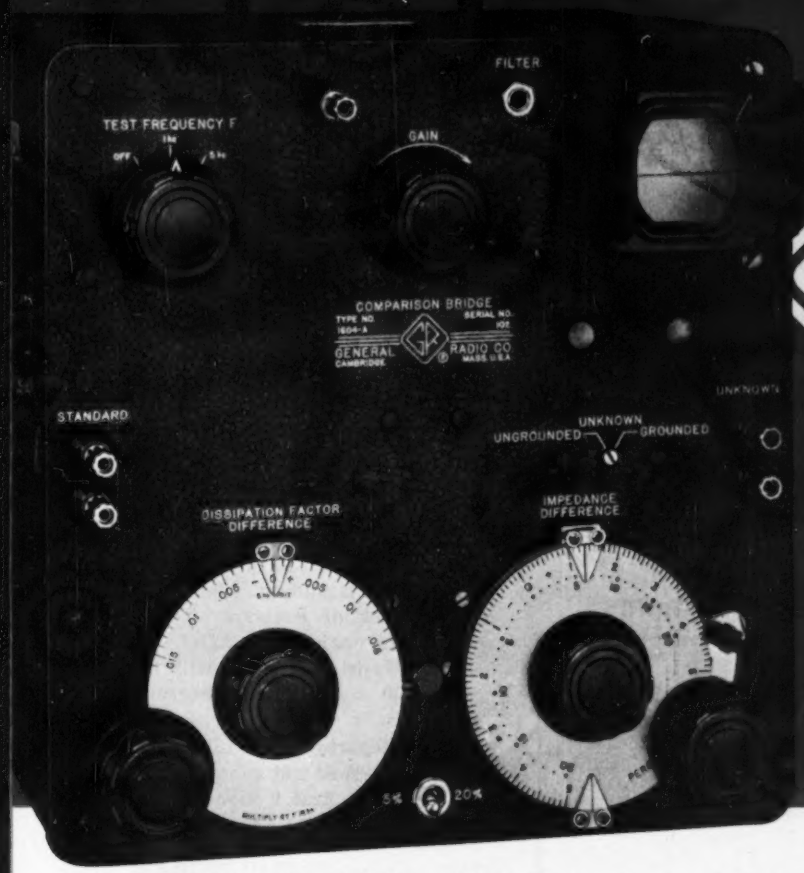
Television Status Around the World

Country	Standards	Sets in Use	Transmitters on	const*	plan.
Albania	625/25/8 mc				
Argentina	625/25/6	12,000	1		5
Australia	625/25/7.5(?)				1
Austria	(tv forbidden by occupation rules)				
Belgium	625/25/7	3,000			5
	819/25/14				
Bielorussia	625/25/8				
Bolivia	525/30/6(?)				
Brazil	525/30/6	45,000	3	4	9
	625/25/6				
Bulgaria	625/25/8				
Canada	525/30/6	150,000	2		5
Chile	525/30/6				2(?)
Colombia	(contract for Bogata cancelled)				
Cuba	525/30/6	100,000	2	1	10
Cyprus	(British equipment reportedly on order)				
Czechoslovakia	625/25/8			1	
Denmark	625/25/7	500	1		1
Dominican Republic	525/30/6	500	1		
Egypt	(French demonstrated temp. station 5/51)				
Finland	625/25/7				
France	441/25/6				
	819/25/14	55,000	3	1	5
Germany (East)	625/25/(?)	300	1		
Germany (West)	625/25/7	2,000	5		3
Great Britain	405/25/5	1,655,446	5		2
Guatemala	525/30/6(?)				3(?)
Hungary	625/25/8				
India	(seriously interested)				
Israel	(seriously interested)				
Italy	625/25/7	4,000	2	1	10
Japan	525/30/6	3,000		1	10
Luxembourg	625/25/7				
Mexico	525/30/6	40,000	4	2	6
Morocco	819/25/14			1	3
Monaco	819/25/14				
Netherlands	625/25/7	7,000	1		5
Nigeria	(British equipment reportedly on order)				
Norway	625/25/7				
Pakistan	(seriously interested)				
Poland	625/25/8			1	
Rumania	625/25/8				
Saar	625/25/7				
	819/25/14			1	
Spain	625/25/7	125		3	
Sweden	625/25/7	100		1	4
Switzerland	625/25/7				3
Tanganyika	(British equipment reportedly on order)				
Thailand	(money available, bids submitted)				
Tunisia	819/25/14				
Turkey	625/25/7			1	
Ukraine	625/25/8				
U. S. A.	525/30/6	18,500,000	129		144
Uruguay	(bids for station recently cancelled)				
U. S. S. R.	625/25/8	77,000	3		
Venezuela	625/25/6		1	2	
Vatican City	625/25/7				1
Yugoslavia	625/25/7			1	2

* Experimental station, station testing or under construction.

▶ **Brazil**—Beset with foreign exchange troubles, Brazil, nonetheless, is showing great interest in tv. An electronics industry has already taken root in the Sao Paulo area and television sets may soon be manufactured internally. Radio sets and components are now

(Continued from page 18)



New!

GR Comparison Bridge

for Rapid and Accurate

Measurements

The Type 1604-A Comparison Bridge is a unique, direct-reading impedance measuring device which materially reduces test and measuring time. It enables the rapid and precise measurement of both impedance and dissipation factor of capacitors, resistors and inductive components. A component of a production lot or an appropriate standard is used for comparison against the unknown.

In operation, "Impedance Difference" and "Dissipation Factor Difference" dials conveniently and accurately indicate the degree by which these characteristics differ from those of the selected standard. For real high-speed sorting, the cathode-ray-tube indicator is easily calibrated at the desired tolerance and used to give an instantaneous visual "go no-go" indication. The instrument is completely self-contained; it includes a bridge circuit, internal 1 kc and 5 kc oscillators, a high-gain non-linear amplifier terminated in a CRO visual detector, and an internal power supply.

The Type 1604-A Comparison Bridge —

★ is ideal for checking ganged potentiometers, condensers and inductors that must track each other to very close tolerances

★ is extremely useful for precisely setting and checking the tap of center-tapped windings or for comparing two windings on the same core.

★ permits rapid and reliable adjusting of one variable component to the value of another . . . the approach to balance is continuously and instantly indicated

★ can be used to measure directly small capacitors in the 1 μμf range.

★ In laboratory, shop or production line the Comparison Bridge will prove invaluable for adjusting, selecting and pairing components within given tolerances.

FEATURES

Two IMPEDANCE DIFFERENCE Ranges — *0 to ±5% range for accurate comparisons — 0 to ±20% for checking components within the common ±10% and ±20% tolerances*

Accuracy of Impedance Measurements

	Resistance	Capacitance	Inductance
1 kc:	2Ω — 20MΩ	50 μf — 50 μμf	500 μh — 250 h
5 kc:	4Ω — 4MΩ	2 μf — 50 μμf	200 μh — 10 h

For these impedances, accuracy is ±0.1% for the 5% switch position.

DISSIPATION FACTOR DIFFERENCE

Range	±.015 at 1 kc; ±0 75 at 5 kc
Accuracy at	1 kc: ±(.0005+2% of impedance difference) 5 kc: ±(.0025+2% of impedance difference)

CRO Visual Detector — *horizontal band of light is used as the indicator — highly non-linear detector amplifier keeps indication on scope over wide ranges of unbalance — continual resetting of gain control is eliminated.*

Zero Adjustment — *adjustable index mark on scope can be offset and locked to compensate for deviation of the standard from the desired nominal value — permits use of any component as a standard*

Dimensions — *12" x 14¼" x 10"*; **Net Weight** — *22½ lbs.*

GENERAL RADIO Company
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

Admittance Meters ★ Coaxial Elements ★ Decade Capacitors
Decade Inductors ★ Decade Resistors ★ Distortion Meters
Frequency Meters ★ Frequency Standards ★ Geiger Counters
Impedance Bridges ★ Modulation Meters ★ Oscillators
Variacs ★ Light Meters ★ Megohmmeters ★ Motor Controls
Noise Meters ★ Null Detectors ★ Precision Capacitors
Pulse Generators ★ Signal Generators ★ Vibration Meters ★ Stroboscopes ★ Wave Filters
U-H-F Measuring Equipment ★ V-T Voltmeters ★ Wave Analyzers ★ Polariscopes

being made. Manufacture of electron tubes including crt's is envisioned.

Brazil has 45,000 sets in use, three transmitters on the air, nine planned and four under construction. The city of Rio de Janiero may soon become operator of the hemisphere's first educational tv station. Brazilians are enthusiastic about television and projection receivers are frequently seen in public places, parks and even vacant lots.

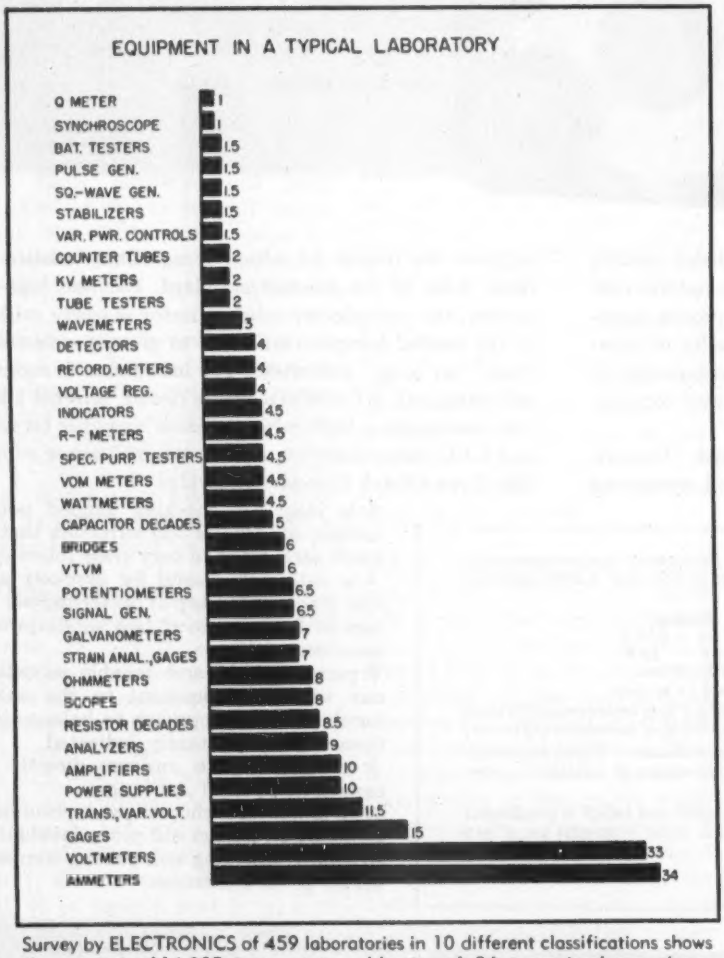
▶**Elsewhere**—Argentina imported 9,293 tv sets during the first eight months of 1953. No additional transmitters are contemplated. There is presently only one station, in Buenos Aires.

Venezuela has a high standard of living and a large market is expected here despite different picture standards. Two stations in Caracas should be on the air by now. A third is scheduled for late 1953.

Television transmitter deals recently fell through in Uruguay and Colombia.

U. S. manufacturers of tv transmitting equipment have reported serious inquiries from El Salvador, Peru, Costa Rica, Republic of the Philippines, New Zealand and Union of South Africa. Inquiries of a more casual nature have been received from Honduras, Formosa, Indonesia, Malaya and Greece.

Average Laboratory Uses 254 Instruments



Survey by ELECTRONICS of 459 laboratories in 10 different classifications shows they contain 116,395 instruments. Identity of 36 types is shown above. Remaining types average less than one and include field-strength meters, spectrometers, sweep calibrators, colorimeters and radiation meters

Financial Roundup

MERGER action by two major manufacturers, along with profit reports and security transactions of other companies in the field, highlight the current financial picture of the electronics industry.

Board of directors of Webster-Chicago and Emerson Radio have recommended merger of the two companies. After approval by stockholders of both companies, Emerson will issue 337,500 shares of its capital stock for the 450,000 shares of Webster-Chicago now outstanding, which is in the ratio of ¾ share of Emerson for 1 share of Webster-Chicago. These shares will be in addition to the 1,935,187 presently outstanding shares of capital stock of Emerson, which will remain unchanged. After the merger, Webster-Chicago will be operated as a division of Emerson.

▶**Profit Reports**—The following companies issued net profit statements for the first 9 months:

Company	1952	1951
AT&T*	$22,819,780	$30,949,435
Avco	6,647,079	7,660,372
Minnesota Mining	11,442,337	11,427,754
Reliance Electric	1,816,140	1,727,215
Remington Rand**	9,557,404	9,836,491

*Net operating income for 10 months
**Earnings for 8 months

▶**Securities Sold**—Aerovox purchased for cash the entire outstanding stock of Acme Electronics of Pasadena. It will be operated as a wholly-owned subsidiary.

Radioactive Products sold 52,176 shares of class A convertible stock at $1.25 per share. The proceeds were added to the company's working capital to facilitate increased volume.

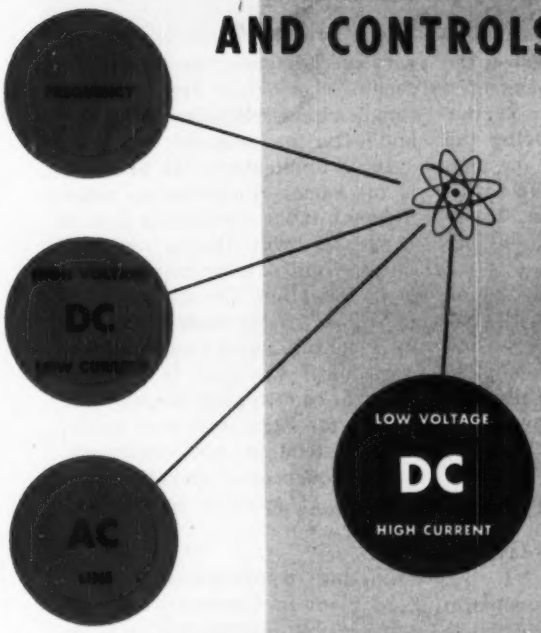
Kentucky Coal Deposit Ups Germanium Supply

GERMANIUM for transistors and crystal diodes has been found in coal ash from an eastern Kentucky deposit. Although the new source may increase substantially the amount of germanium available,

(Continued on page 20)

SORENSEN

REGULATES AND CONTROLS



Nobatron Model E-6-5

The NOBATRON* maintains stabilized DC voltage under changing line and/or load conditions.

A complete line of catalog models are available, with output voltages of 6, 12, 28, 125, and 200 VDC, from 5 to 350 amperes.

Sorensen Nobatrons eliminate battery and generator troubles. They combine high regulation accuracy with maximum dependability and minimum maintenance.

All models are attractively finished. Most can be furnished either for relay rack mounting or in cabinets for bench-top use. Most units are metered; all are adequately protected against overload by suitable fuses and breakers.

COMMON NOBATRON SPECIFICATIONS

Input voltage range	95-130 VAC, single ϕ, 50-60 ~ High-current units 208/115, 3ϕ, 4-wire, wye.
Output voltage range	Adjustable ± 10% with rated accuracy, — 25% with lesser accuracy.
Regulation accuracy	± 0.2% from 1/10 to full load.
Ripple voltage	1% RMS. Time constant 0.2 seconds.

* Reg. U. S. Pat. Off. by Sorensen & Co., Inc.

WIDER OUTPUT VOLTAGE RANGE MODELS

Nobatron-RANGERS* are designed to meet the demand for power supplies similar to the Nobatron but with wider output voltage ranges.

Nobatron-RANGERS are continuously adjustable over extended output ranges, yet provide regulation accuracies of ±0.25% against line and/or load. Other specifications are identical to those of the standard Nobatrons.

Three models are available, the SR-30, SR100, SR-2. Capacities, respectively, are 3 - 30 VDC at 3 - 30 amperes, 3 - 135 VDC at 1 - 10 amperes, and 100 - 300 VDC at 1 - 10 amperes.

Investigate NOW the cost of a NOBATRON installation versus the overall cost of less satisfactory DC sources.

OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:

B-NOBATRONS (high-voltage, low-current DC Supplies)
FREQUENCY CHANGERS VARIABLE AUTO TRANSFORMERS
SATURABLE CORE REACTORS AC LINE REGULATORS

SPECIFY **SORENSEN**

For Complete Information Write

SORENSEN & COMPANY, INC.
375 Fairfield Avenue Stamford 1, Conn.

demand is expected to keep its price firm at $350 a pound.

Germanium production has been running about 1,000 pounds annually; demand may reach 15,000 pounds when transistor production swings into high gear. Original source for the increasingly important material was smoke from zinc furnaces.

Automatic Pilot Speeds River Barges

AT FIRST glance, an automatic pilot for a tugboat seems about as useful as lace curtains at the windows of the pilot house. But when the seconds and minutes saved by its use add up to hours or even days less for a given trip the idea begins to make sense.

Sperry Gyro, which claims a preponderance of the hundred-odd radar installations on tugs plying the Mississippi-Ohio rivers system, has been working for at least two years on a gadget that will tie radar to the rudder. The final result is a control that can be hung on the outside of the radar console or in any other convenient small space. Linkage between the two, so far, is via the pilot.

▶**Steady as You Go**—The pilot's control is a small housing not unlike the throttle of a Diesel locomotive. With the handle in the lower circular slot, he can steer the tug electronically by means of a magnetic amplifier in a box mounted nearby. By moving the handle upwards into the top slot, the last course setting is held with the help of a gyrocompass. Movement of the handle corrects to any new desired course.

Pushing a 1,000-foot string of barges up the Mississippi is slow work at best, sometimes as slow as a knot an hour. Even a good pilot is likely to oversteer a little, especially at night. Whenever he does, he must turn his rudder in the other direction. And while steering, he slows his progress. With the automatic pilot, it may be possible to cut a fifteen-day trip to ten days.

On the Hudson River-Champlain Canal system there is one skipper who saves two hours out of every twenty-four with the new device.

Modern Mark Twain can either steer or automatically hold a course with this new electronic pilot. Big-boat skippers can use it instead of shouting to the helmsman from the radar screen

'Automation' Comes To Modern Industry

Feedback loops built into complex controls presage automatic industrial production

BUILT INTO FUNCTIONING PLANTS, servomechanisms based on the feedback principle are operating complex industrial processes faster and better than men can.

In all applications the principle is the same—A continuous measurement of the work being done is compared with instructions set into the control instrument's 'memory'. Deviation, the so-called 'error signal', is fed back to the controls, continuing or decreasing the work until the goal is reached. Then the control shuts the machine off, or starts the cycle over again.

By extending this principle, whole sequences of operations can be done at amazing speeds and accuracies.

▶**Existing Applications**—A new Ford plant in Cleveland operates entirely by 'automation'—automatic industrial production—and 250 men do twice the work 2,500 men did before. One instrument balances crankshafts, by automatically controlling drilling and grinding operations.

In continuous-strip production, such as steel, paper and rubber, servomechanisms control the strip width, continuously readjusting machines to maintain a tolerance impossible with old methods involving sample caliper measurements.

Television Assumes Role in Cold War

East and West stations vie in divided Berlin; relay spans Red Zone

REGULAR television broadcasting in Germany has opened a new battlefield in the propaganda war for men's minds. Programs are now

(Continued on page 22)

Select the right

KROHN-HITE OSCILLATOR

in the ULTRA-LOW FREQUENCY RANGE

REMEMBER: All KROHN-HITE OSCILLATORS provide sine and square wave simultaneously

- **COMPACT and LOW PRICED**

price $350.00

model 400-A

SPECIFICATIONS:

FREQUENCY RANGE: 0.009 to 1,100 cps., continuously variable in five decade bands.

FREQUENCY ACCURACY: Calibration ±2%, drift is less than 1% including warm-up and less than .05% for ±10% change in line voltage.

SINE WAVE OUTPUT:

VOLTAGE: 30 volts maximum, adjustable continuously with a logarithmic output control calibrated from .01 to 10 rms. volts.

AMPLITUDE: Varies less than ±1 db over entire range from 0.009 to 1,100 cps. and less than ±0.25 db for ±10% change in line voltage.

POWER: 25 mw maximum across 1,000 ohms.

DISTORTION: Less than 1% at any output level setting.

HUM: Less than 0.1% at any output level setting.

SQUARE WAVE OUTPUT: 10 volts peak to peak maximum.

- **STANDARD RACK MOUNTING**
- **SINGLE ENDED OR BALANCED OUTPUT**

price $375.00

model 400-C

SPECIFICATIONS:

FREQUENCY RANGE: 0.009 to 1,100 cps., continuously variable in five decade bands.

FREQUENCY ACCURACY: Calibration ±2%, drift is less than 1% including warm-up and less than .05% for ±10% change in line voltage.

SINE WAVE OUTPUT:

VOLTAGE: 30 volts maximum, adjustable continuously with a logarithmic output control calibrated from .01 to 10 rms. volts.

AMPLITUDE: Varies less than ±1 db over entire range from 0.009 to 1,100 cps. and less than ±0.25 db for ±10% change in line voltage.

POWER: 100 mw maximum across 1000 ohms.

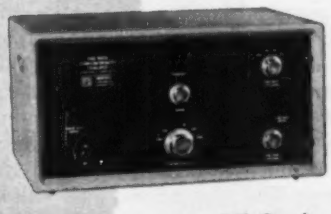
DISTORTION: Less than 1% at any output level setting.

HUM: Less than 0.1% at any output level setting.

SQUARE WAVE OUTPUT: 10 volts peak to peak maximum.

- **WIDE RANGE**
- **ULTRA-LOW DISTORTION**
- **EXCELLENT AMPLITUDE CONSTANCY**

price $950.00



model 410-A

SPECIFICATIONS:

FREQUENCY RANGE: 0.02 to 20,000 cps., continuously variable in six decade bands.

FREQUENCY ACCURACY: Calibration ±2%, drift is less than 1% including initial warm-up and less than .01% for ±10% change in line voltage.

SINE WAVE OUTPUT:

VOLTAGE: 15 volts maximum adjustable continuously by a "T" pad, and by a step switch providing 100:1, 10:1, 2:1, and 1:1 attenuation.

AMPLITUDE: Varies less than 0.25 db over entire frequency range from .02 to 20,000 cps.

POWER: 10 mw maximum across 500 ohms.

DISTORTION: Less than 0.1% over entire frequency range from .02 to 20,000 cps.

HUM: Less than .1% at any output level.

SQUARE WAVE OUTPUT: 10 volts peak to peak maximum.

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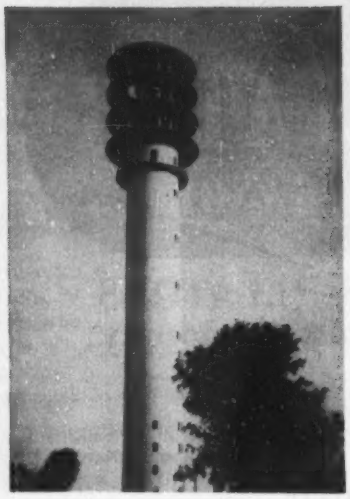
580 MASSACHUSETTS AVENUE
DEPT. E. CAMBRIDGE 39, MASS.

All Krohn-Hite Instruments fully guaranteed for one year against defective materials and workmanship. Prices net — f.o.b. Cambridge. *Write for free catalog.*



Microwave relay links new German tv stations. Tower houses repeater station

broadcast from transmitters in both East and West Berlin. The West Berlin transmitter is linked by vhf relay across the Soviet Zone with the Northwest German Radio (NWDR) network; the East Berlin station may soon be joined by other stations in the Hartz Mountains near the West German border and in Thuringia.

The Voice of America reports that it has no plans to acquire television equipment, although it will make filmed programs available to West German broadcasters. Radio Free Europe, a private organization broadcasting to Russia and her satellites, likewise disclaims interest in television broadcasting. Such programs "would reach only a small portion of Europe's captive population due to propagation difficulties and would be overly vulnerable to interference and jamming."

▶**Limited Audience**—Only 1,200 television sets are in use in West Berlin; about 200 are in bars. Chief reason for the small tv audience is economic; the cheapest German television sets cost $300, almost six months income for the average German. Television receivers in East Berlin are Russian 7-inch sets. Most of these have been installed in public places, presumably to discourage channel jumping. Both East and West German television stations broadcast a 625-line, 25-frame picture using a 7-mc bandwidth with f-m sound.

NWDR operates stations in Hamburg, Hanover, Langenberg (in the Ruhr basin) and Cologne. The stations are linked by microwave radio relay stations, like the one in the photograph, sited at 40-mile intervals. Stations are planned for Frankfurt, Stuttgart and Munich.

The 200-mc vhf relay that ties West Berlin into the network terminates atop a 500-ft tower built on a 200-ft hill at Hoebeck in the British zone. Signals received from West Berlin 80 miles away are relayed to the other network stations through Hamburg.

Lawrence Tri-Color Tube In Production

NOW CALLED 'CHROMATRON', the tricolor tube (p 81 and 146, Nov. 1951) developed by E. O. Lawrence of the University of California is being produced in pilot-plant quantities by Chromatic Television (Paramount Pictures) of Oakland, Calif. At a closed-circuit demonstration for the press in New York City, Richard Hodgson, president of Chromatic, said 200 have already been made. The tube is 22 inches in diameter but, due to the wire grid arrangement integral to construction, it produced an 18-in. picture.

▶**Claims**—Demonstrated with a flying-spot scanner and Kodachrome slides, the picture was very bright. Hodgson said less scanning power is now needed for the color sync pulses, as a result of increasing the number of vertical grid wires and other improvements. A major advantage claimed for the new tube is its adaptability to mass assembly methods. Mass-produced color grids and mass-produced phosphor-striped screens may be mass-assembled without much hand tailoring, giving a color tube for about twice the cost of conventional monochrome types.

The tube was demonstrated on the CBS color system but is adaptable to NTSC signals. It can be made as short as monochrome tubes usually are.

Militronic Equipment: Too Complex?

"Perhaps," say top brass as drive gains to reduce both cost and upkeep

LEVELED jointly at military men and equipment designers is the charge that excess gimmicks and gadgets in modern weapons are killing our boys with kindness. Critics also contend that weapons cost more than they are worth, that they should be far simpler in design and construction. The charge is popular with economy-minded congressmen and a widespread conclusion has been drawn that we are designing ourselves into bankruptcy.

Much of the complexity arises from wider application of electronic devices. A modern battleship uses 9,000 electron tubes, a B-36 heavy bomber depends upon 2,100 tubes for navigation and control. An F-86 Sabrejet employs 600. In all, 15,000,000 tubes are currently used in military equipment. Costwise, electronic gear aboard a destroyer brings $3,000,000 today as against $40,000 during World War II.

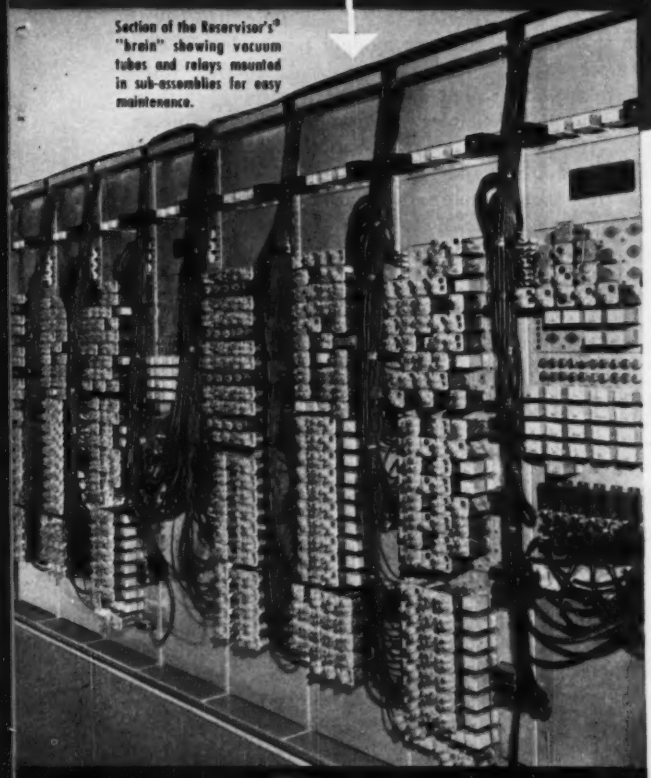
Maintenance costs likewise measure complexity of new weapons. Experience shows that each 100 million dollars worth of military electronic equipment needs one billion dollars worth of maintenance before it wears out.

▶**How to Simplify**—Interest is mounting in simple and reliable equipment. Department of De-

(Continued on page 24)

1400 CLARE RELAYS

in "brain" of first completely automatic reservations system

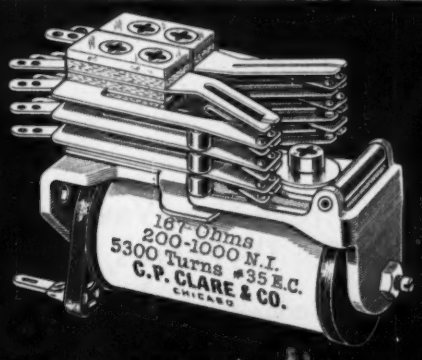


Section of the Reservisor's* "brain" showing vacuum tubes and relays mounted in sub-assemblies for easy maintenance.

IMMEDIATE INFORMATION on reservations for American Airlines' 1000 flights a day is available to airline personnel through the use of The Teleregister Corporation's Magnetronic Reservisor,* the first completely automatic reservations system.

With its 1500 tubes and 1400 CLARE relays, the Reservisor* is also a high-speed computer, a storage and filing system, data transmission system, display device, and a logging or recording unit.

In their vast experience with electrical controls, Teleregister's engineers have acquired a knowledge of relays that is wide and deep. The importance which they attached to selecting the best possible relays for the Magnetronic Reservisor* stands out in these their own words, "Choice of components, equipment layout, and circuitry were aimed at reliability. First of all, the incidence of trouble should be held to the minimum. This has been accomplished by using only the finest components and by using a sturdy relay instead of a vacuum tube wherever possible." Their deliberate choice of CLARE relays is therefore charged with meaning for industrial designers.



Clare Type J Relay of which 1400 are used in Magnetronic Reservisor* is an extremely compact and lightweight relay.

CLARE sales engineers are located in principal cities to cooperate in the development or "custom-building" of relays to meet your most difficult design applications. Call them or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable address: CLARELAY.

*Trade Mark of The Teleregister Corp.

CLARE RELAYS

First in the Industrial Field

fense procurement officials are offering incentive contracts rewarding manufacturers who design and perfect weapons that do their job and are simpler than predecessors. Britain's RAF recently ordered 25 'poor-man's' radar sets. Hand-operated, the sets cost $11,200 and use only 50 tubes. Shying from 'cheap-and-dirty' equipment, U. S. military men too have nevertheless embarked on a program of simplifying equipment and reducing upkeep through unitization and automatic fault location.

▶**Plug-In Radar** — Unitization means building up equipment with independent black boxes that can be plugged in when needed. A unitized radar set aboard a battleship would be replete with all extras while the same set, stripped to its essentials, would serve adequately aboard an LST.

Fault-locating devices of sufficient sensitivity to predict failure simplify maintenance in an emergency. Repair consists of plugging in a complete spare unit, with overhaul chores deferred to a convenient time and place.

Transistor Weds Magnetic Amplifier

Ceremony yields rugged servo system with high gain, fast response and high power output

USE OF TRANSISTORS in conjunction with magnetic amplifiers was suggested shortly after the transistor was announced. Each was known to be extremely rugged. The absence of standby power inherent in both devices showed promise.

The transistor is an efficient amplifier at low power levels and the magnetic amplifier excels at high power levels.

The marriage is in a servo amplifier by the Industrial Control Co. of Wyandanch, New York. The transistor acts, in effect, as a preamplifier for the magnetic amplifier power stage.

▶**Simple Circuit**—The circuit used is quite simple, and yet it offers power gains of several thousand with a speed of response limited only by the operating frequency.

Input and output may be either d-c or a-c, and negligible power is consumed by the amplifier when no power is being delivered to the load.

Work is still going on to develop new designs, although the existing circuit is directly applicable to a wide variety of control applications in its present form.

A number of improvements are expected to result from use of better transistors, when they become available in sufficient quantity to make their use in commercial equipment feasible. Higher gains may be obtained by using cascaded transistors.

The new development makes available to industry a highly efficient and versatile packaged servo amplifier that is virtually indestructible and may be expected to have a long life. With present models power levels of a fraction of a watt to 500 watts may be controlled by such low-power devices as thermocouples, synchros, small potentiometers and photocells. The transistor-magnetic amplifier may also be used in other applications where low-frequency amplification is desired.

TV Servicing Business Patterns

Survey of dealers reveals large variations in efficiency of operation and charges for work

THE pattern of radio and television service business operation shows up as hectic and varied in a recent GE survey of 2,175 full-time dealers.

Average dollar volume for all dealers in 1951 ranged from $6,150 per technician in the small shop to $8,200 per technician in shops having over 10 technicians. Corresponding figures for shops specializing in tv work are $7,330 to $8,500.

▶**Jobs Per Technician**—An average of 35 jobs is completed per week by each technician, but the average is by no means representative. Some of the six to nine man shops fixed over 60 sets per week per technician, while others got less than 14 jobs per week out of each technician.

Billing per service call also showed an extreme variation from the $8 average figure for tv and $5.50 for radio. Combining all dealers, the extremes show 9 percent of the firms averaging $3 per call as a low and $14 per call as a high. On the other hand, over 75 percent had average billings in the range of $5 to $10.

▶**Contracts**—In firms having under 5 technicians, less than 10 percent of the tv calls were under service contract. With large firms specializing in tv service, a surprisingly high figure was reported for 1951; 75 percent of the calls were under service contract.

Percent of service jobs completed in the home on tv sets ranged from 78 percent for the small dealer to 86 percent for those having over 40 technicians.

Triple-Use Waveguide For TV, Phones, Power?

"Barlow's Tube" in London has U. S. counterpart at Bell Labs and Signal Corps

FOR many years, power companies have also been using their high-tension lines stretching across the country as carriers for wired-wireless radiotelephone communication. More recently, the Signal Corps has been experimenting with

(Continued on page 26)

A GOOD NAME TO REMEMBER
WHEN YOU NEED DEPENDABLE
COMPONENTS... *faster!*

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Electronic Components Division

Stackpole Carbon Company, St. Marys, Pa.

Also • LINE AND SLIDE SWITCHES • CERAMAG® (ferrite) CORES • IRON CORES • MOLDED COIL FORMS • GA "GIMMICK" CAPACITORS, etc.

Want more information? Use post card on last page.

the G-string, a single wire coated with enamel or plastic along which very high-frequency currents travel. Radar has made familiar the use of the waveguide, a hollow tube through which microwaves pass.

▶**Marriage of Convenience**—H. M. Barlow, a professor at the University of London, proposes the use of a pair of hollow copper tubes that will carry multiple telephone conversations within, television signals on the outside surface and power within the copper. So far, he has confined his research primarily to the radio phase of the problem.

Bell Telephone Laboratories engineers, whose main concern likewise is communications, admit to "strenuous activity" in the development of long-distance techniques using circular waveguides at 50,000 megacycles—only slightly different from those employed by Barlow.

The new Bell type L-3 coaxial cable system handles 1,800 circuits. The number might be more than doubled with the waveguide technique.

Business Briefs

▶**Cheaper,** better transistors may not be far away, if a new "substance" recently announced by Brown-Allen Chemicals, Inc. of New York City lives up to claims made for it.

▶**Super-sniffer** that smells gas leaks by electronics and sounds an alarm if all is not well is now being used to detect leaks in hermetically sealed aircraft equipment.

▶**Swiss** financial group representing the Union des Banques Suisses may invest in tv set manufacturing in Italy. It has been estimated that 100,000 sets could be absorbed by the Italian market in 1953.

▶**If the** Bureau of Internal Revenue takes over Grand Central Palace for office space later this year, as has been reported, the 1954 IRE National Convention will be held in the Kingsbridge Armory, Bronx, N. Y., according to an announcement by J. W. McRae, president, and G. W. Bailey, executive secretary of the Institute.

▶**Australia** will spend a total of $20 million on military electronic equipment with local manufacturers. New types of radar equipment will not, however, be developed in Australia as previously planned because of insufficient time. U. S. and British designed radar will be used. It will be made by local firms having overseas affiliations.

▶**Satellite** tv station for Hawaii may be put into operation this year by KGMB-TV in Honolulu as part of a plan to extend tv service to six major islands extending over a chain 300 miles long.

▶**Power** consumption of tv home receivers adds an estimated $200 million a year to the utility industry's revenues, according to C. B. Jolliffe of RCA. Tv studios and transmitters increase income another $2.5 million. In New York alone, an income of $12 million during the year ending June 30, 1952 is attributed to home tv usage.

MEETINGS

FEB. 4-6: Western Computer Conference, Hotel Statler, Los Angeles, Calif.
FEB. 5-7: IRE Southwestern Conference and Electronics Show, Plaza Hotel, San Antonio, Texas.
FEB. 5-7: Audio Fair, Alexandria Hotel, Los Angeles, Calif.
MARCH 9-12: NEMA, Edgewater Beach Hotel. Chicago, Ill.
MARCH 19-20: National Collegiate Industry-Government Conference on Instrumentation, Michigan State College, East Lansing, Mich.
MARCH 23-25: Sixth Annual Conference for Protective Relay Engineers, A & M College of Texas, College Station, Texas.
MARCH 23-26: IRE National Convention, Waldorf-Astoria Hotel and Grand Central Palace, New York, N. Y.
MARCH 23-27: Western Metal Exposition, Pan-Pacific Auditorium and Western Metal Congress, Statler Hotel, Los Angeles, Calif.
APRIL 18: Seventh Annual Spring Technical Conference, Cincinnati IRE, Cincinnati, Ohio.
APRIL 27-30: Spring Meeting of USA National Committee of URSI-IRE Professional Group on Antennas and Propagation, National Bureau Of Standards, Washington, D. C.
APRIL 27-MAY 8: British Industries Fair, Birmingham & London, England.
APRIL 28-May 1: Seventh Annual NARTB Broadcast Engineering Conference, Burdette Hall, Philharmonic Auditorium, Los Angeles, California.
APRIL 29-MAY 1: 1953 IRE-AIEE Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.
MAY 1: American Association of Spectrographers Symposium, Chicago, Ill.
MAY 11-13: IRE National Conference on Airborne Electronics, Dayton, Ohio.
MAY 18-21: 1953 Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.
MAY 18-23: Third International Congress On Electroheat, Paris, France.
MAY 24-28: NAED, 45th Annual Convention, Conrad Hilton Hotel, Chicago, Ill.
MAY 24-28: Scientific Apparatus Makers Association Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.
JUNE 15-19: Exposition of Basic Materials for Industry, Grand Central Palace, New York N. Y.
JUNE 16-24: International Electro-acoustics Congress, The Netherlands.
JUNE 20-OCT. 11: German Communication and Transport Exhibition, Munich, Germany.
AUG. 19-21: IRE Western Electronic Show & Convention, Municipal Auditorium, San Francisco, Calif.
AUG. 29-SEPT. 6: West German Radio and Television Exhibition, Duesseldorf, Germany.
SEPT. 1-3: International Sight and Sound Exposition, Palmer House, Chicago, Ill.
SEPT. 21-25: Eighth National Instrument Exhibit, Sherman Hotel, Chicago, Ill.

Filtered by Filtron

LOCKHEED F-94

Filters by Filtron

BOEING B-47

FILTRON'S Engineering division, with its completely equipped screen room facilities, is always available to measure and recommend RF Interference Filters for your equipment, to meet and exceed the Radio Interference requirements of MIL-I-6181.

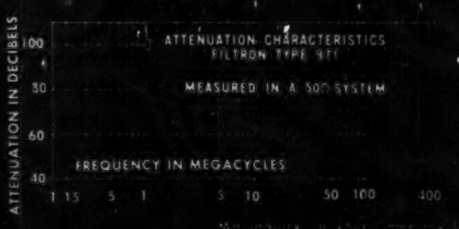
FILTRON'S production facilities are suppying more RF Interference Filters for use in military electronic equipment than ever before, to meet the nation's requirements.

FILTRON... the LEADER IN RF INTERFERENCE FILTERS... has pioneered:

Sub-miniature Filters
High-temperature Filters
RF Filters to withstand Shock and Vibration
Wide band Multi-section Units
RF Filters "Custom Designed" to meet YOUR requirements

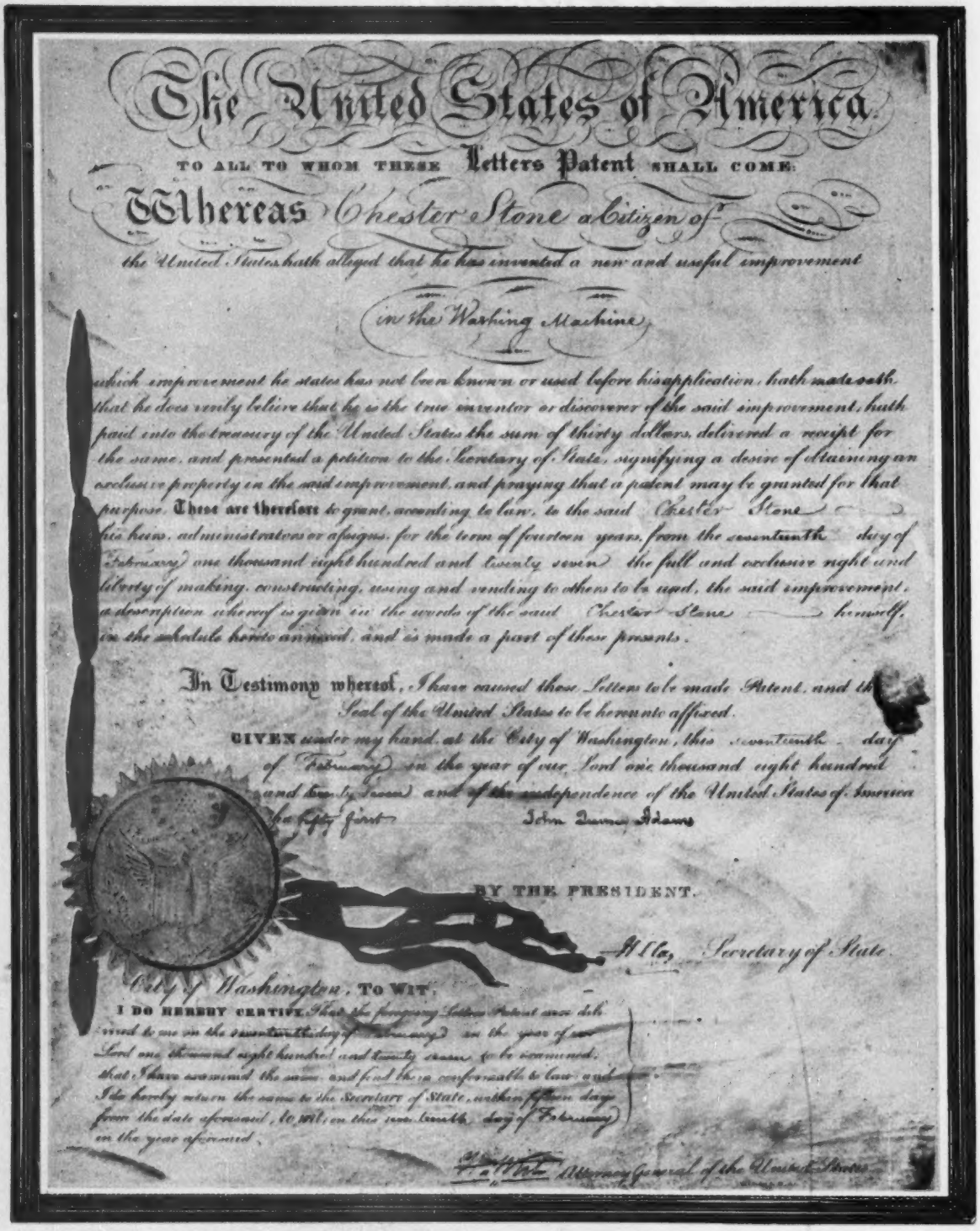
FILTER FA 971
1.5 AMP, 130V AC, 400 CY
Size: 1" x 1" x 1"

FILTER FA 970
155 MA, 130V AC-DC, 50-1000 CY
Size: 1 1/2" x 1 1/4" x 1 1/8"



THE FILTRON COMPANY INC. FLUSHING, LONG ISLAND, NEW YORK

What does this 126



The United States of America.

TO ALL TO WHOM THESE Letters Patent SHALL COME:

Whereas Chester Stone a citizen of the United States hath alleged that he has invented a new and useful improvement in the Warping Machine

which improvement he states has not been known or used before his application, hath made oath that he does verily believe that he is the true inventor or discoverer of the said improvement, hath paid into the treasury of the United States the sum of thirty dollars, delivered a receipt for the same, and presented a petition to the Secretary of State, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose. These are therefore to grant, according to law, to the said Chester Stone his heirs, administrators or assigns, for the term of fourteen years, from the seventeenth day of February one thousand eight hundred and twenty seven the full and exclusive right and liberty of making, constructing, using and vending to others to be used, the said improvement, a description whereof is given in the words of the said Chester Stone himself, in the schedule hereto annexed, and is made a part of these presents.

In Testimony whereof, I have caused these Letters to be made Patent, and the Seal of the United States to be hereunto affixed.

GIVEN under my hand, at the City of Washington, this seventeenth day of February in the year of our Lord one thousand eight hundred and twenty seven and of the independence of the United States of America the fifty first

John Quincy Adams

BY THE PRESIDENT.

H Clay Secretary of State

City of Washington, To Wit:

I DO HEREBY CERTIFY, That the foregoing Letters Patent were delivered to me on the seventeenth day of February in the year of our Lord one thousand eight hundred and twenty seven, to be examined, that I have examined the same and find the same conformable to law, and I do hereby return the same to the Secretary of State, within fifteen days from the date aforesaid, to wit, on this seventeenth day of February in the year aforesaid.

Wm Wirt Attorney General of the United States

year old Patent mean to you?

One hundred twenty-six years of experience, know-how, inventiveness—call it what you will—is something we alone can give you in our particular field.

For Chester Stone, the inventor of the washing machine of this patent, was the father of our founder, and the great uncle of our president.

One hundred twenty-six years later to the month, we continue to be very much interested in washing machines, but in a different way. Today we manufacture insulating bushings for the electric motors, fibre bobbins for the time controls, and laminated paper base phenolic sleeves for mounting insulation.

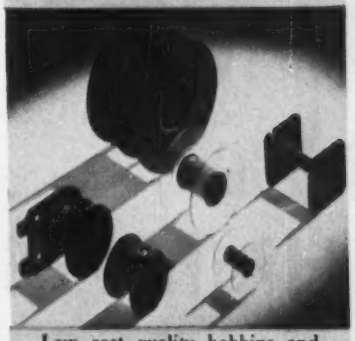
The United States has become a nation of specialists in the years since John Quincy Adams, the President; Henry Clay, the Secretary of State; and William Wirt, the Attorney General, signed this patent in 1827.

We have become specialists in the manufacture of spiral wound insulating tubing, sleeves, and bobbins. They can be furnished in diameters as small as 3/64" ID, various wall thicknesses and lengths, and of many materials including hi-dielectric kraft, fish paper, and plastic films. We can produce these custom-made quality products to close tolerances. They are low in cost and our service is unsurpassed.

The use of our products by many hundreds of America's leading manufacturers is ample testimony that this heritage of one hundred twenty-six years has well equipped us to satisfactorily fulfill a large number of their specific requirements.

Sales representatives are located in principal cities. We would welcome an opportunity to serve you.

For more than a quarter century Stone has aided the expanding automotive and electrical industries by the development of low cost spiral insulating tubes.



Low cost quality bobbins and spools by Stone are meeting the exacting specifications of leading coil winding firms.

Stonized spiral wound phenolic coil forms, collars, and assemblies are finding increasing acceptance by the electronics industry.

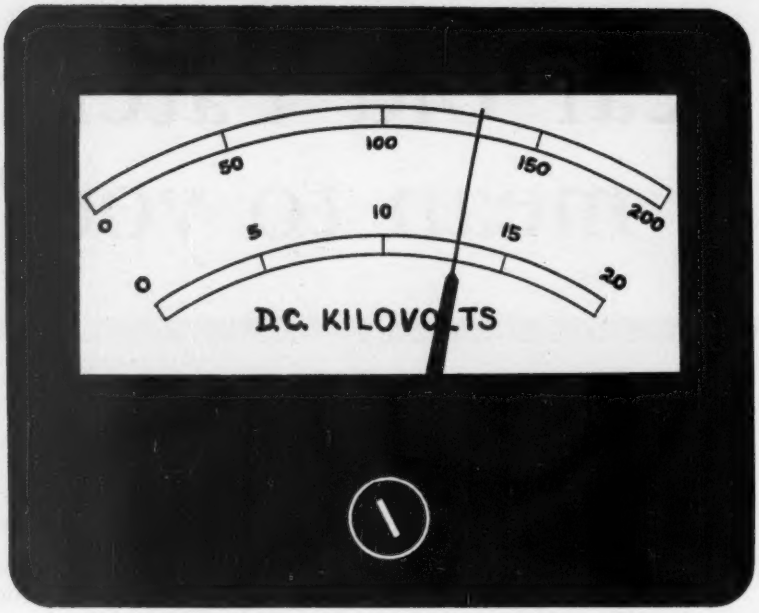
Stone's plain or printed containers and specialties are widely used in the pharmaceutical and industrial fields.

STONE PAPER TUBE COMPANY

INCORPORATED

900-922 Franklin Street, N. E. Washington 17, D. C.

DO YOU USE



High-Voltage CAPACITORS?

Plastic Capacitors, Inc., achieve capacitor designs in smaller sizes and higher working temperatures with increased life expectancy.

This is accomplished by *uniquely* processing plastic films for use as the solid dielectric in their capacitors.

Our catalog describes these features including capacitors with voltage range up to 60 Kv. but AC capacitors and higher voltage DC capacitors are available on special order.

Write today on your company letterhead for your copy of this comprehensive catalog.

Your inquiries are invited.

Plastic Capacitors, Inc.

PLASTIC FILM CAPACITORS • HIGH VOLTAGE POWER PACKS • PULSE FORMING NETWORKS

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KEEP YOUR PRODUCTION ROLLING!

Thin wall 3-core construction assures flux continuity...prevents "dry" joints.

Contains only Virgin tin & lead. Tin — 99.75% pure. Lead — 97.97% pure.

Only Multicore has Ersin Flux — high grade water-white rosin, homogeneously activated.

Non-corrosive even after long exposure to humidity.

Wets metal rapidly due to reduced surface tension.

Vigorous fluxing action.

Leaves only pure rosin after soldering.

Perfect joints on difficult metals & alloys even if oxidized.

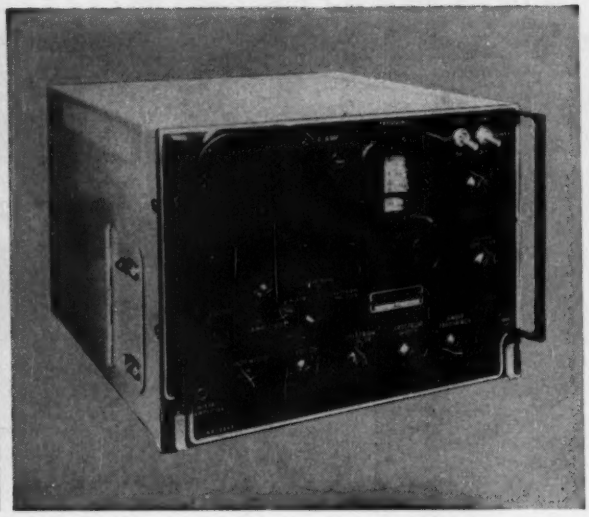
Total % flux to solder less than many single cored solders.

Rigid quality control insures same standards in every Multicore reel.

Conforms with QQ-S- 571-b and all other pertinent Federal Specifications.

MULTICORE SALES CORP.

MULTICORE SOLDERS LTD.



NE-11-20-S SPECTRUM ANALYZER

Description

The Spectrum Analyzer is test equipment designed primarily for use with aircraft radar and beacon equipment operating over a frequency range of 8470 to 9630 mc/s. Housed in a compact portable carrying case, the whole assembly weighs approximately 90 pounds.

In operation, the Spectrum Analyzer displays on an oscilloscope a pattern representative of the distribution of energy among the various frequencies in the output of a pulsed oscillator. This equipment is equal to our government models TS-148/UP.

Applications

This very sensitive micro-wave receiver will provide accurate measurement of the spectra of radio frequency oscillations in radar and beacon equipment. It will also measure, within its own range, frequencies of echo boxes, magnetrons, test sets, local oscillators and a variety of resonant cavities. It can also be used to check magnetron pulling and AFC circuits, and as a frequency-modulated oscillator to tune T/R Boxes and R/T Boxes in transmitter-converters.

The Analyzer is so sensitive that the magnetron signal can usually be picked up at some distance from the source, thus making the equipment easy to use in any convenient location.

Specifications

Power Supply	50-1200 Cps; 105-125 Volts; 125 Watts
Frequency-meter Range	Calibrated directly from 8470 mc/s to 9630 mc/s
Sweep Frequencies	Continuously Variable from 10 to 30 Cps
Attentuation (Spectrum Amplitude)	Uncalibrated. Variable from 3 to 70 db.
Operating Temperature Range	—40°C. to +55°C.
Frequency swing of analyzer r-f oscillator (sawtooth FM)	40 to 50 mc/s
Overall i-f bandwidth at half power points	50 kc/s
Sensitivity to CW — Spectrum Amplified Pos. — 80 db. below 1 watt for 1 inch of deflection on Oscilloscope Screen.	
— Spectrum Position — 55 db. below 1 watt for 1 inch of deflection of Oscilloscope Screen.	
Maximum dispersion of spectra	1.5 mc/s per inch
Maximum error	± 5 megacycles

We will gladly furnish all details regarding specifications, prices, and delivery.

Write, wire or telephone for information.

NORTHEASTERN ENGINEERING INC.

Manchester, New Hampshire

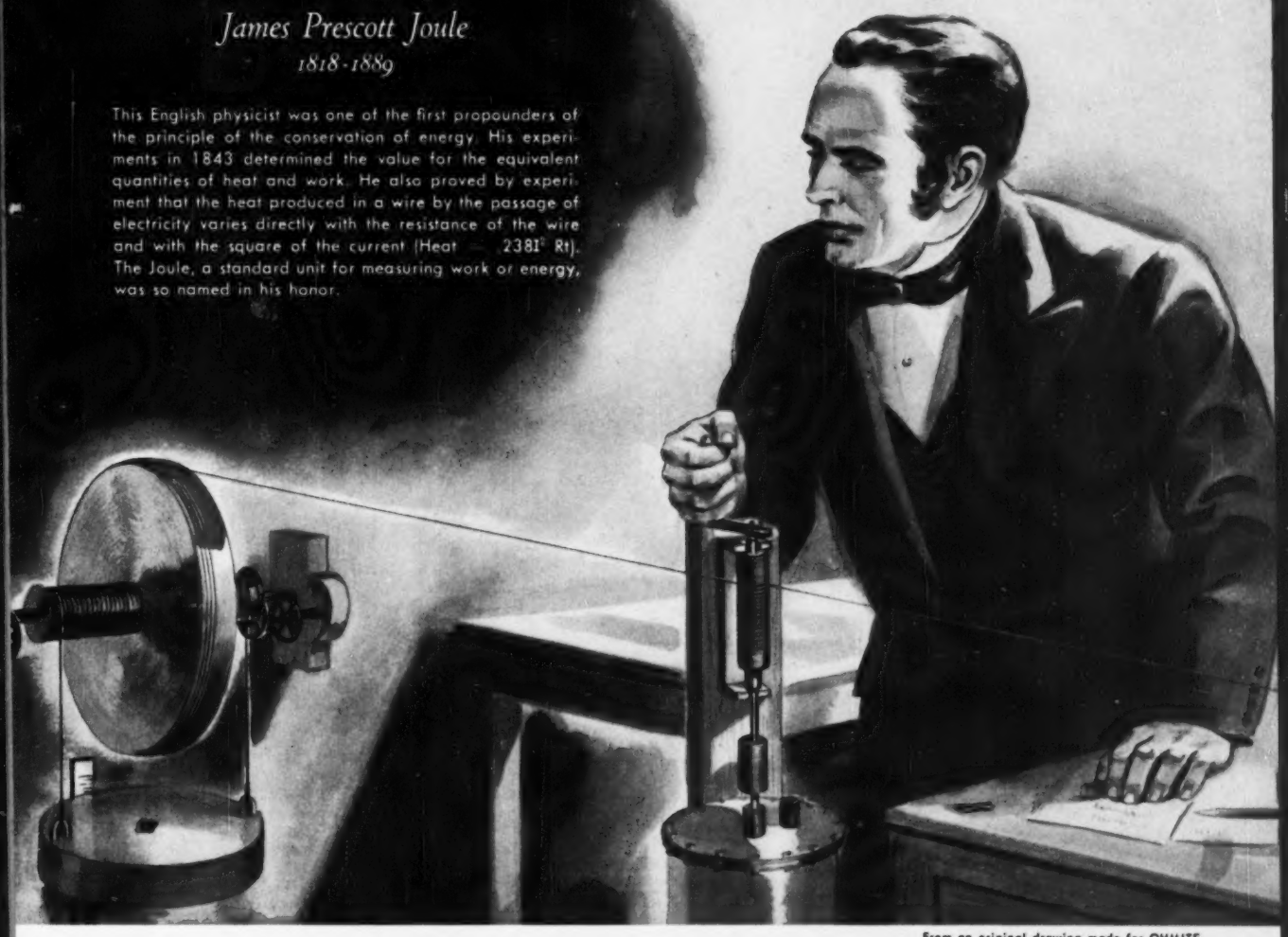
Telephone 2-6485

JOULE

. . . FIRST to accurately determine the mechanical and electrical equivalent of heat

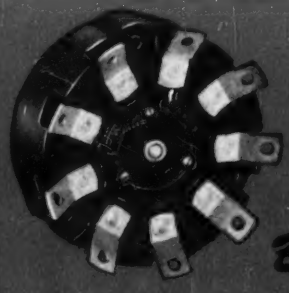
James Prescott Joule
1818-1889

This English physicist was one of the first propounders of the principle of the conservation of energy. His experiments in 1843 determined the value for the equivalent quantities of heat and work. He also proved by experiment that the heat produced in a wire by the passage of electricity varies directly with the resistance of the wire and with the square of the current (Heat .238I² Rt). The Joule, a standard unit for measuring work or energy, was so named in his honor.



From an original drawing made for OHMITE.

OHMITE®.. FIRST in Tap Switches *today*



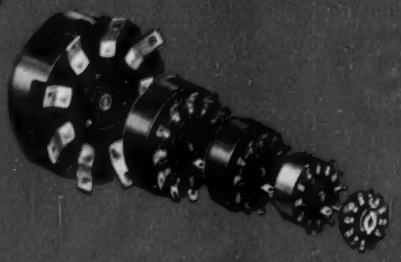
OHMITE all-ceramic power type tap switches are preferred by industry over all other makes on the market. Their compactness, permanent ceramic and metal construction, and proven ability to give years of dependable, trouble-free service . . . make them ideal for the toughest applications.

Specify OHMITE when you want the best!

Be Right with OHMITE

RHEOSTATS • RESISTORS • TAP SWITCHES

OHMITE®



ALL-CERAMIC • POWER TYPE

Tap Switches

FIVE SIZES

AMPS.	MODEL No.	MAX. V. (A-C)	No. TAPS
10	111	150	2 to 11
15	212	150	2 to 12
25	312	300*	2 to 12
50	412	300*	2 to 12
100	608	300	2 to 8

*150 volts between taps

COMPACT
DEPENDABLE

Here's the most *complete* line of power type, rotary tap switches. These rugged units have high current capacity . . . plus six outstanding features! 1—Ceramic construction, to provide permanent insulation, unaffected by arcing. 2—Extreme compactness, with terminals convenient for wiring. 3—Silver-to-silver contacts to eliminate contact maintenance. 4—Self-cleaning rotor contact. 5—"Slow-break" mechanism, with positive cam-and-roller for "slow-break, quick-make" action for A-C. 6—"Dead" switch shaft, insulated by strong ceramic hub.

OHMITE MANUFACTURING COMPANY
4816 Flournoy Street
Chicago 44, Illinois

Write on company letterhead for this comprehensive OHMITE catalog

Be Right with OHMITE RHEOSTATS • RESISTORS • TAP SWITCHES

...has everything you need for PRINTED CIRCUITS

First to provide Tubes and Transistors that are correctly designed for quick, efficient printed circuit assembly. For the ultimate in portable performance, combine Raytheon's high-efficiency, filamentary Subminiature Tubes with Raytheon's Junction Transistors.

Subminiatures	Filament Volts	Ma.	Plate Volts	Screen Volts	Grid Volts	Plate Ma.	Screen Ma.	Mutual Cond. Umhos.	Voltage Gain	Plate Resis. Meg.
1AG4 Output Pentode	1.25	40	41.4	41.4	-3.6	2.4	0.6	1000	35†	0.18
1AH4 RF Pentode	1.25	40	45.	45.	0	0.75	0.2	750		1.5
1AJ5 Diode-Pentode	1.25	40	45.	45.	0	1.0	0.3	425	50	0.3
1V6* Mixer-Pentode	1.25	40	45.	45.	0	0.4	0.15	200**		1.0
1V6* Osc.-Triode			45.	—	Rg = 1 meg.	0.4	—	550		
1AK4 RF Pentode	1.25	20	45.	45.	0	0.75	0.2	750		1.5
1AK5 Diode-Pentode	1.25	20	45.	45.	5 meg.	0.5	0.2	280	40	0.4

†Power Output — milliwatts **Conversion Conductance

***Type 1V6 is a high performance, low battery drain converter. Note the comparison with 1R5 using 45 volt supply.**

	1V6	1R5
Total Cathode Current (ua)	960	2750
Conversion Conductance (umhos)	200	235
Plate Resistance (megohms)	1.0	0.6
Conversion Gain (load = 175K)	30	32
Equiv. Noise Resistance (ohms)	70K	180K

PNP JUNCTION TRANSISTORS
(Average Characteristics at 30° C)

	CK721	CK722
Collector Voltage (volts)	-1.5	-1.5
Collector Current (ma.)	-0.5	-0.5
Base Current* (ua.)	-6	-20
Current Amplification Factor*	40	12
Power Gain* (db)	38	30
Noise Factor* (1,000 cycles) (db)	22	22

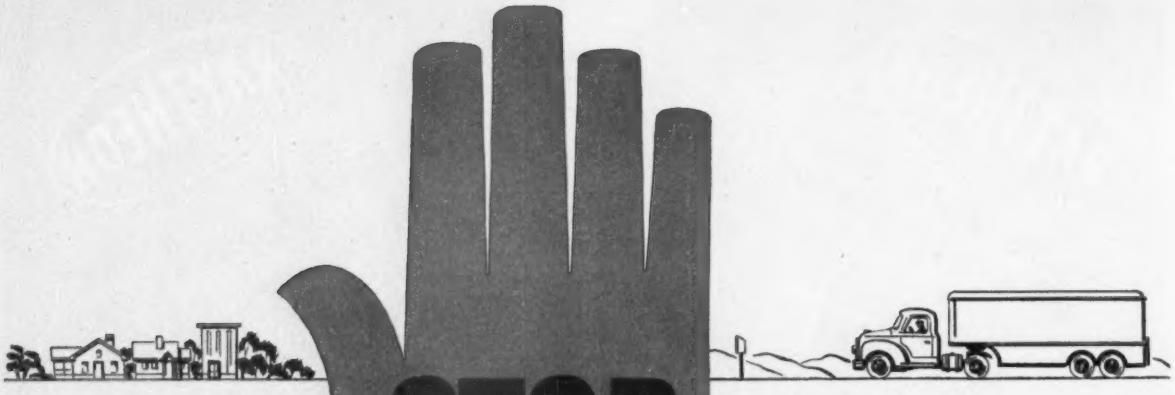
*Grounded Emitter connection

RAYTHEON

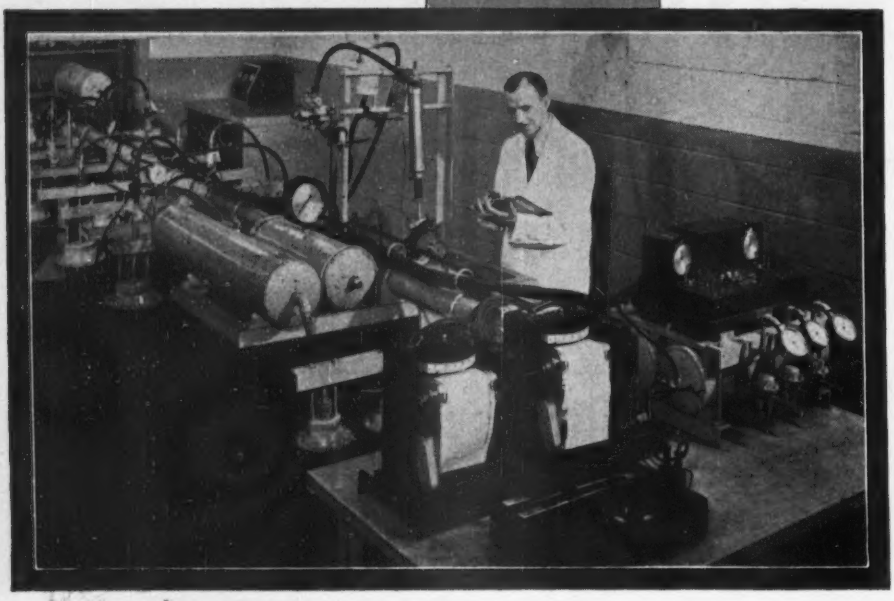
RAYTHEON MANUFACTURING COMPANY

RAYTHEON MAKES ALL THESE:

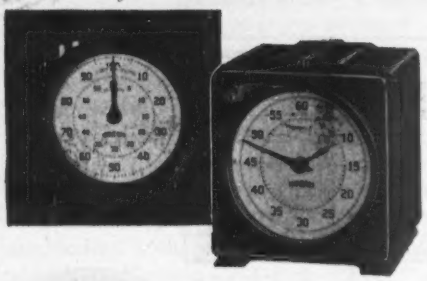
Want more information? Use post card on last page.



TIME TO STOP...IN TIME!



SPLITTING THE SPLIT SECOND at the Bendix-Westinghouse Engineering Research Department laboratories is absolutely essential in exploring every possible braking requirement for transportation tomorrow.



STANDARD ELECTRIC TIME has been serving industry, government and educational institutions for almost seventy years with fine precision instruments and equipment for the accurate measurement of time.

STANDARD ELECTRIC MODEL S-1 Clocks are a part of the modern laboratory controls testing equipment and timing devices shown in this photograph... they accurately measure air brake application and release transmission time to one-hundredth of a second... The timers are started instantaneous to brake pedal movement transmitted through an electronic circuit and are stopped by means of a highly sensitive electro pneumatic switch located at pre-determined stations in the air brake system.

STANDARD
SINCE 1884

THE STANDARD ELECTRIC TIME COMPANY
97 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

New Waldes Truarc E-Ring Dispenser* Speeds Assembly, Cuts Time and Costs

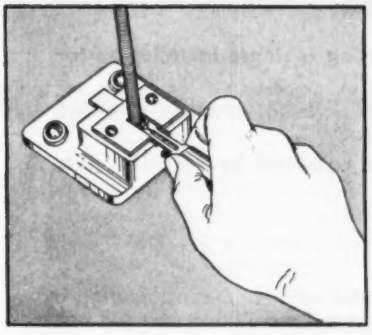
*U. S. PAT. PENDING

FOR GREATER TIME-SAVING, more efficient handling and assembly of Waldes Truarc E-rings,* here is an automatic, precision tool. Designed for one-at-a-time repeating action, the Truarc E-ring Dispenser can be easily operated by any assembly worker.

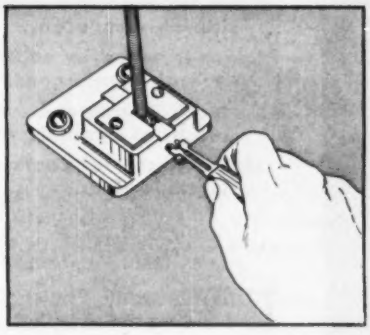
WALDES TRUARC E-RINGS (sizes 5133-9 to 50 inclusive) are now available packed on stackrods in quantities ranging from 250 to 500 pieces per rod. Stackrods are precision-made, allow re-loading in seconds. No interruptions to continuous flow in assembly.

**Dispensers for Waldes Truarc Crescent Rings (series 5103) also available.*

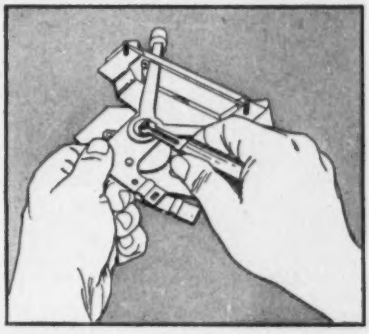
SIMPLE 1, 2, 3 ASSEMBLY OPERATION



1 Truarc applicator is pushed forward and grips a single E-ring.



2 Applicator withdrawn (new ring automatically feeds into place).



3 Ring is installed in groove on shaft. No waste time or motion.

WRITE, TODAY, FOR COMPLETE BROCHURE ON WALDES TRUARC E-RING DISPENSER

WALDES

TRUARC

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WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,415,852; 2,420,921; 2,420,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,602; 2,487,803; 2,491,305; 2,509,091 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc.
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☐ Please send me the new Waldes Truarc E-ring Dispenser brochure.

☐ I am also interested in dispensers for Crescent Rings.

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1403-03

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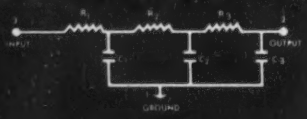
1404-02 1406-02

VERTICAL INTEGRATOR



1405-01

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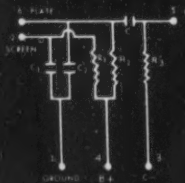

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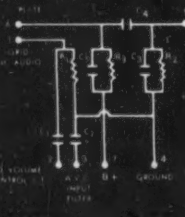
1407-03

AUDIO OUTPUT CIRCUITS



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ERIE electronic printed circuits

PERFECTED BY MORE THAN A DECADE OF DEVELOPMENT

. . . OFFER THESE ADVANTAGES

Fewer soldered connections mean less installation time.

Fewer connections mean fewer wiring errors.

Circuit stability is improved through simplification.

Costs for procurement and stock maintenance are considerably reduced.

Space is saved by substituting a single installation for several installations.

Reduced space requirements permit reduced size and weight of complete product.

Other material costs are reduced by smaller size, lighter weight.

ERIE Electronic Printed Circuits achieve miniaturization by bonding the complete or partial circuit to a ceramic base plate, thus combining the work of several capacitors in one installation unit.

Erie began the development of Printed Circuits in 1940, and today they are widely used by manufacturers of electronic products to effect a reduction in size, weight, and cost; and to improve performance. ERIE Electronic Printed Circuits have helped to solve design and production problems in radio and television receivers, hearing aids, military equipment, and many other products employing electronic control. Write for catalog and samples.

ERIE components are stocked at leading electronic distributors everywhere.

TRADE ERIE MARK

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

Main Offices: **ERIE, PA.**

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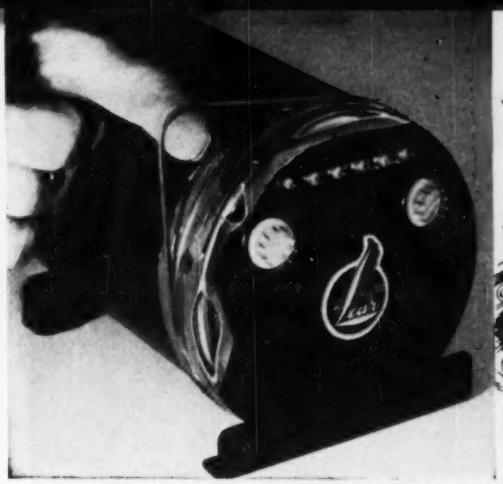
Factories: **ERIE, PA. • LONDON, ENGLAND • TORONTO, CANADA**



Courtesy Lear, Inc.

in instruments where reliability is imperative

SILASTIC* works

where other materials fail

To assure maximum service life and accuracy, engineers at Lear, Incorporated, planned to protect their new vertical gyro-mechanism from corrosion by housing it in a completely inert and dehydrated atmosphere.

Sealing the housing, however, proved to be more easily said than done. Despite the most elaborate precautions, solder and flux fumes often penetrated the joint and contaminated the delicate mechanism. Once sealed, it was impossible to reopen the case without loss of the expensive cover and harness.

To both of these problems a simple and ingenious solution was found. A thin O-ring of Silastic molded to fit snugly under the cover flange is used to exclude the corrosive fumes generated in soldering a metal strip over the entire joint. The Dow Corning silicone rubber O-ring is not damaged by soldering temperatures. And, the gyro-mechanism is just as accessible for repairs as the contents of a hermetically sealed can of coffee.

Lear also uses a large ring washer of Silastic at each end of the housing to serve as resilient, shock-absorbing cushions for the apparatus at stratospheric temperatures.

And that's just one of hundreds of examples of how Silastic is used to improve the performance of products ranging from cable to traction motors, from domestic steam irons to aircraft.

*T. M. Reg. U. S. Pat. Off.

For more information about the properties or fabricators of Silastic, mail this coupon today or phone our nearest branch office.

Dow Corning Corporation, Dept. BE-2, Midland, Mich.

Please send me:

- ☐ Silastic Facts 10a with new data on properties and applications of all Silastic stocks and pastes.
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Another Machlett Contribution Toward Better, More Reliable Tubes for Industrial Service

ML-6257 is the latest addition to Machlett's line of tubes specially designed and processed for use in electronic heating equipment. It fulfills a long standing requirement for a long life tube which can safely provide 3 kw of heater output with reliability and economy.

ML-6257—with its companion tubes ML-6256 and ML-6258—makes available design and performance characteristics which provide a higher standard of value for all applications—including AM, FM & TV broadcasting.

ML-6257 is rated 5 kw plate dissipation with cooling provided through an integral anode water jacket. Type ML-6256 with the same ratings uses the Machlett automatic seal water jacket. Type ML-6258 designed for forced-air cooling is rated at 3 kw plate dissipation.

Phone, wire or write for more information—Machlett Field Engineers will be glad to assist in any tube application problem.

RATINGS AND CHARACTERISTICS

Electrical Data—General

Filament voltage	12.6 Volts
Filament current	27 Amps
Amplification Factor	21
Interelectrode Capacitances:	
Grid-Plate	20 uuf
Grid-Filament	22 uuf
Plate-Filament	0.7 uuf

Maximum Ratings—Class C Telegraphy
(Key down conditions per tube without modulation)

D-C Plate Voltage	5500 Volts
D-C Grid Voltage	—1500 Volts
D-C Plate Current	1.5 Amps
D-C Grid Current	.22 Amp
Plate Input	7 kW
Plate Dissipation	5 kW

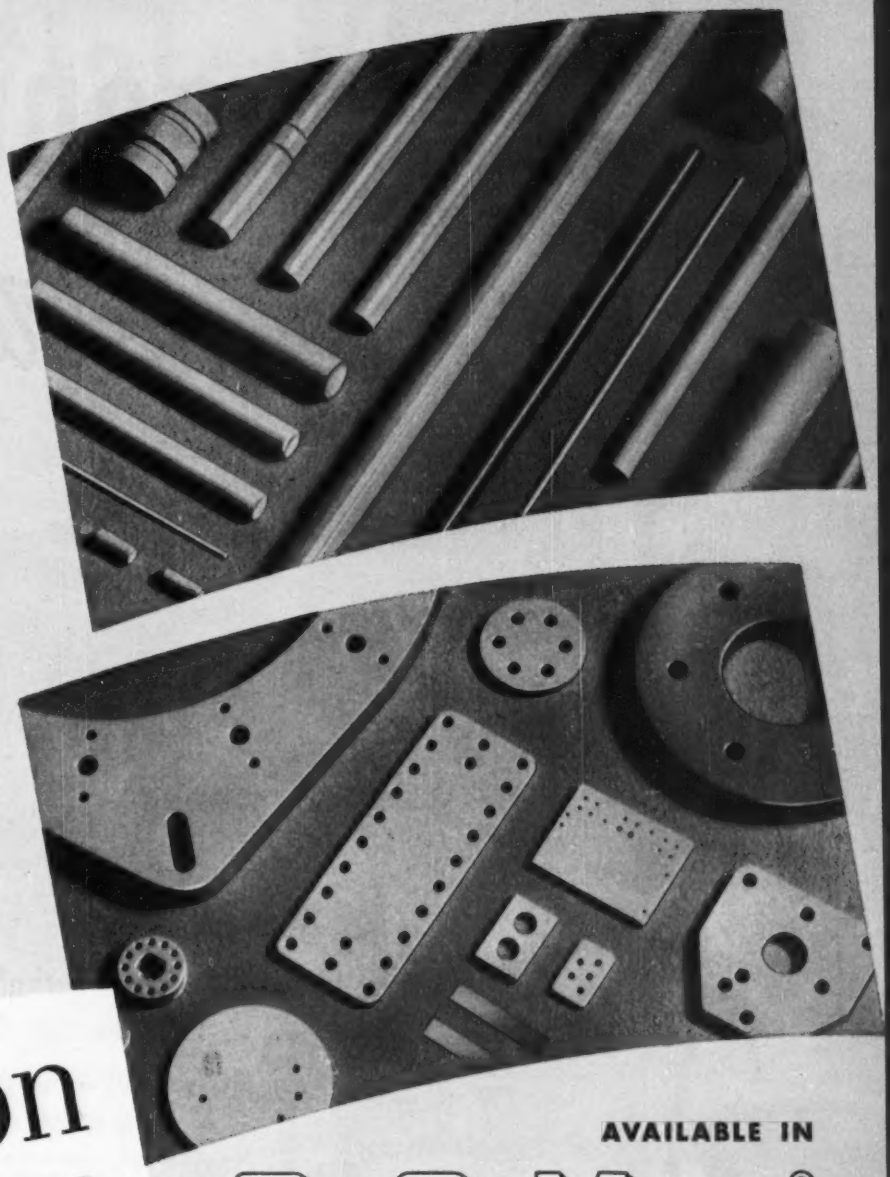
MACHLETT — OVER 50 YEARS OF ELECTRON TUBE EXPERIENCE

MACHLETT LABORATORIES, INC., SPRINGDALE, CONNECTICUT

Want more information? Use post card on last page.

- Outside diameter of tubes and rods as small as .062" diameter centerless ground to tolerance of ±.0001".
- Rods free of camber for precision shafts.
- Rods and tubes centerless polished to 5 micro inch RMS finish 5√.
- Cylindrical parts ground both inside and outside to diameter tolerance of ±.0005" with concentricity of .001" TIR. Sizes up to 8½" O.D. by 24" long are available.
- Holes as small as .187" diameter can be economically lapped to tolerance of ±.001".
- Plates and discs up to 50 square inches can be precision ground. Flat parts up to 4 square inch area are ground flat and parallel simultaneously on two sides; flat within .0002", parallel within .0005", and thickness tolerance .001" is practical.
- Parts lapped flat within a few light bands. Special parts have been lapped to .008" thickness.

As a rule of thumb: On critical dimensions which lend themselves to grinding, AlSiMag ceramics can be furnished with the accuracy of comparable precision metal parts. AlSiMag ceramics are more wear resistant than steel and, in many designs, can be manufactured to close tolerances at lower cost.



Precision TOLERANCES

AVAILABLE IN

ALSIMAG®

CUSTOM MADE TECHNICAL CERAMICS

Each year we have added more equipment and gained more skill and experience in grinding AlSiMag ceramics. We like difficult and complicated problems. If you have a tough one, send it to us. We'll tackle it.

51ST YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

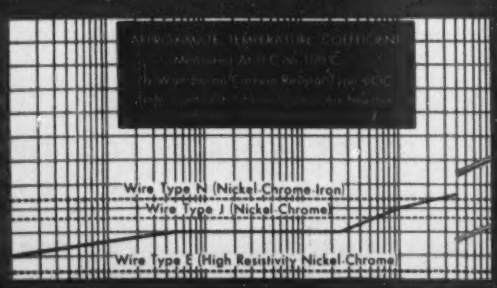
OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • PHILADELPHIA, 1649 North Broad St., Stevenson 4-2823 • CLEVELAND, 5012 Euclid Ave., Express 1-6685 • SOUTHWEST: John A. Green Co., 6815 Oriole Drive, Dallas 9, Dixon 9918 • NEW ENGLAND, 1374 Massachusetts Ave., Cambridge, Mass., Kirkland 7-4498 • LOS ANGELES, 5603 N. Huntington Drive, Capitol 1-9114 • CHICAGO, 228 N. LaSalle St., Central 6-1721 • ST. LOUIS, 1123 Washington Ave., Garfield 4959

Ingenuity is *in resistors too!*

New Materials — New Techniques — New Advantages
Features in 4 New IRC Resistors

1 IRC Type BOC Boron-Carbon ½-Watt PRECISTOR Meets All Requirements of MIL-R-10509 Specification

No other non-wire-wound resistor combines the advantages of this all-new Boron-Carbon unit. Type BOC reduces the temperature coefficient of conventional deposited carbon resistors—provides high accuracy *and* long-time stability—replaces high value wire wound precisions at savings in space and cost. You'll find it adaptable to a host of critical circuitry needs—in electronics and avionics, communications, telemetering, computing and service instruments. Send for full details in Catalog Data Bulletin B-6.



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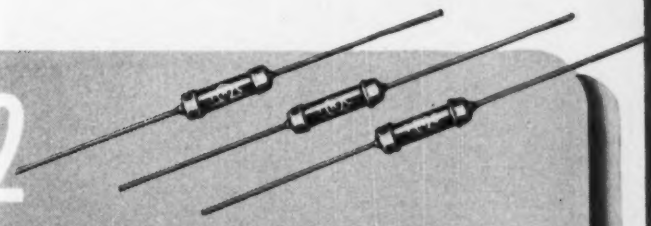
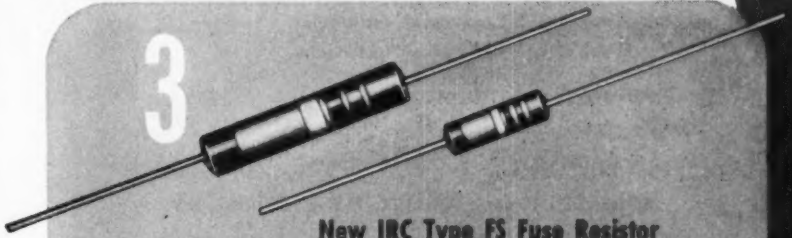


New IRC Type DCC (Deposited Carbon) Small-Size, High-Stability Resistors

This is the latest small-size addition to IRC's famous line of deposited carbon PRECISTORS. Conservatively rated at ½ watt, it combines accuracy and economy—assures high stability, low voltage coefficient, and low capacitive and inductive reactance in high frequency applications. Recommended for:—Metering and voltage divider circuits requiring high stability and close tolerance—High frequency circuits demanding accuracy and stability—Other critical circuits in which characteristics of carbon compositions are unsuitable and wire-wound precisions are too large or expensive. Type DCC meets Signal Corps Specification MIL-R-10509. Complete technical data in Catalog Bulletin B-7.

3



New IRC Type FS Fuse Resistor

This completely insulated unit functions as a resistor under normal conditions and as a fuse under abnormal conditions. Small, compact, stable, it can be wired into a circuit as easily as a molded wire-wound resistor. Bulletin B-3.

4 New IRC Type WW Precision Wire Wounds Surpass JAN-R-93 Characteristic B Specifications

	Original Resist.	1st Cycle % Chge	2nd Cycle % Chge	3rd Cycle % Chge	4th Cycle % Chge	Resist at End of 100 hrs. load	Total % Chge	% Chge from Last Temp. Cycle to End of 100 hrs. load %	Resistance Chge at End of 100 Hrs. Load only % (no cycling)
1	100.010	+ .04	+ .04	+ .05	+ .05	100.050	+ .04	— .01	100.040 — .02
2	100.000	+ .03	+ .04	+ .03	+ .05	100.060	+ .06	+ .01	100.000 0
3	100.000	+ .01	+ .02	+ .02	+ .05	100.000	0	+ .05	100.050 — .02
4	100.000	+ .02	0	+ .02	+ .02	100.000	0	— .02	100.040 — .01
5	100.010	+ .03	+ .04	+ .04	+ .05	100.000	0	— .05	100.030 — .03
6	100.000	0	+ .03	+ .04	+ .04	100.100	+ .1	+ .06	99.980 0
7	100.000	+ .04	+ .05	+ .04	+ .04	100.070	+ .07	+ .03	100.000 0
8	100.000	+ .03	+ .05	+ .05	+ .05	100.050	+ .05	0	100.000 0
9	100.000	+ .04	+ .03	+ .05	+ .04	100.010	+ .01	— .03	100.050 0
10	100.000	+ .02	+ .02	+ .02	+ .04	100.010	+ .01	— .03	100.000 0
11	100.000	0	+ .01	+ .01	+ .03	100.000	0	— .03	

For full information on these products, or assistance in adapting them to any specific application, write IRC. Types BOC and DCC are currently available on short delivery cycles to manufacturers of military equipment only.

Boron-Carbon PRECISTORS • Power Resistors • Voltmeter Multipliers • Insulated Construction Resistors • Low Wattage Wire Wounds • Volume Controls • Voltage Dividers • Non-Inductive Wire Wounds • Semiconductor Contact PRECISTORS • Ultra-HF and High Voltage Resistors • Insulated Chokes

IRC

Wherever the Circuit Says ~~~

INTERNATIONAL RESISTANCE COMPANY

401 N. Broad Street, Philadelphia 8, Pa.

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Mail Coupon Today for Full Details of These New IRC Resistors

INTERNATIONAL RESISTANCE CO.,
403 N. BROAD ST., PHILADELPHIA 8, PA.

Please send me full data on the following checked items:—

- ☐ Type BOC Boron-Carbon PRECISTORS
- ☐ Type WW Precision Wire Wounds
- ☐ Type DCC Deposited Carbon PRECISTORS
- ☐ Type FS Fuse Resistors
- ☐ Name and Address of Nearest IRC Distributor

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....CITY.....ZONE...STATE.....

VOLTAGE REGULATED POWER SUPPLY

MODEL 700

The Kepco Model 700 features one regulated voltage supply with excellent regulation, low ripple content and low output impedance.

SPECIFICATIONS

OUTPUT VOLTAGE DC: 0-350 volts continuously variable.

OUTPUT CURRENT DC: 0-750 milliamperes continuous duty.

REGULATION: In the range 30-350 volts the output voltage variation is less than ½% for both line fluctuations from 105-125 volts and load variation from minimum to maximum current.

RIPPLE VOLTAGE: Less than 10 millivolts.

FUSE PROTECTION: Input and output fuses on front panel. Time delay relay is included to protect rectifier tubes.

POWER REQUIREMENTS: 105-125 volts, 50-60 cycles.

OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. Either positive or negative terminal of the supply may be grounded. DC terminals are isolated from the chassis. A binding post mounted on the front of the panel is available for connecting to the chassis. All terminals are also brought out at the back of the chassis.

METERS:

Ammeter: 0-1 ampere, 4" rectangular.
Voltmeter: 0-500 volts, 4" rectangular.

PHYSICAL SPECIFICATIONS: Cabinet height 22¾", width 21¾", depth 15¼". Rack panel height 21", width 19", color gray, panel engraved.

CONTROLS: Power on-off switch, H.V. on-off switch, H.V. control.

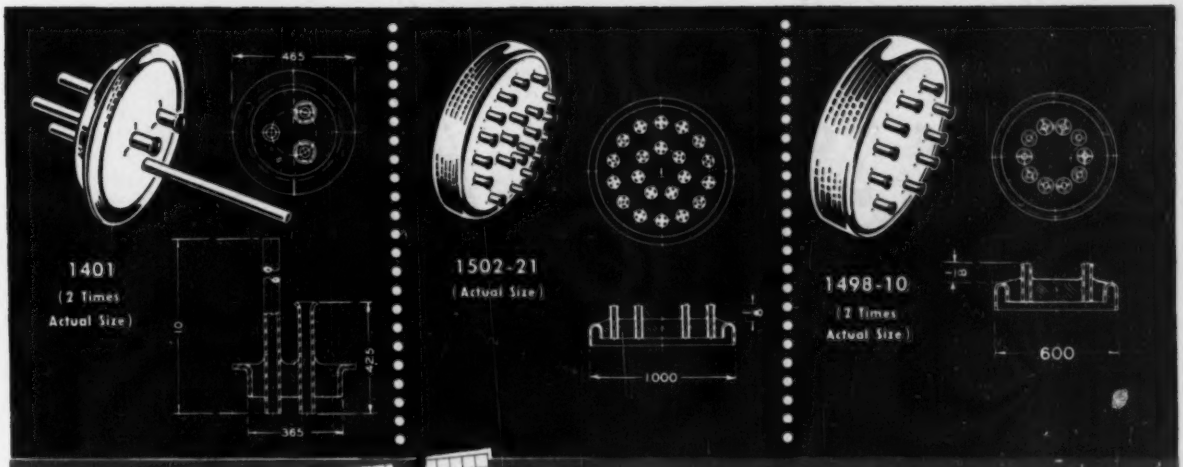
FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. #1

ADDITIONAL MODELS AVAILABLE IN THE 700 SERIES VOLTAGE REGULATED POWER SUPPLIES

Volts	Current	Model
0-350	0-0.75 Amp.	700
0-350	0-1.50 Amp.	710
0-350	0-2.25 Amp.	720
0-350	0-3.00 Amp.	730
0-600	0-0.75 Amp.	750
0-600	0-1.50 Amp.	760
0-600	0-2.25 Amp.	770
0-600	0-3.00 Amp.	780

KEPCO LABORATORIES, Inc.

131-38 SANFORD AVENUE FLUSHING 55, NEW YORK



No Matter What Your Needs Are in *Tubular* FEED-THROUGH SEALS, HERMETIC Can Satisfy Them

● Write detailing your problem for immediate attention, and ask for your FREE copy of HERMETIC's informative brochure, the most complete presentation ever offered on hermetic seals.

Specialist engineers and quality production have enabled HERMETIC to develop the Tubular Seals shown and many others with these advantages:

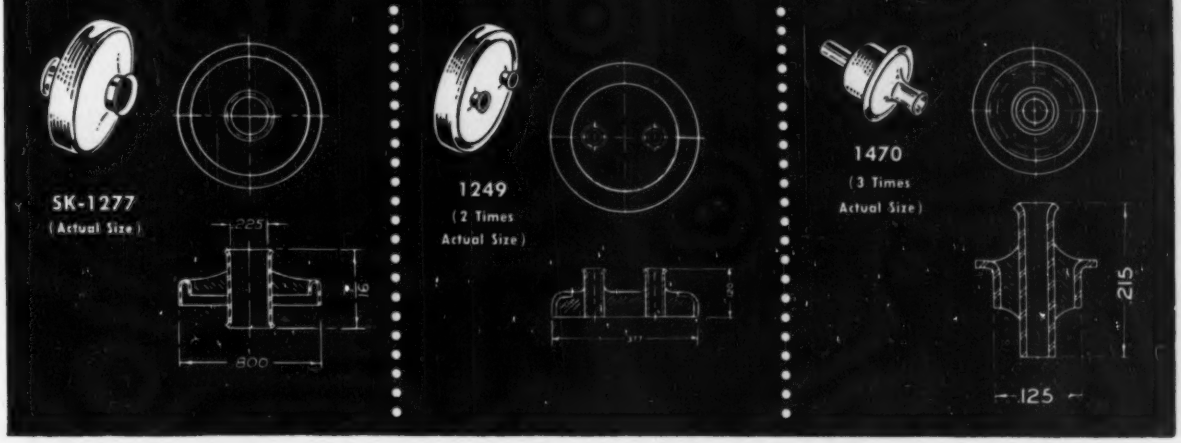
- *Labor saving due to elimination of 1 solder joint per terminal*
- *Parts saving because leads can be brought through from equipment to final terminal board connection*
- *Higher current carrying capacity through use of copper leads*
- *Space saving, both inside and outside unit, resulting from minimum lengths of tubing*
- *Available in extra lengths for current carrying and evacuation*
- *Wide variety of sizes, layouts and tubings for every application*

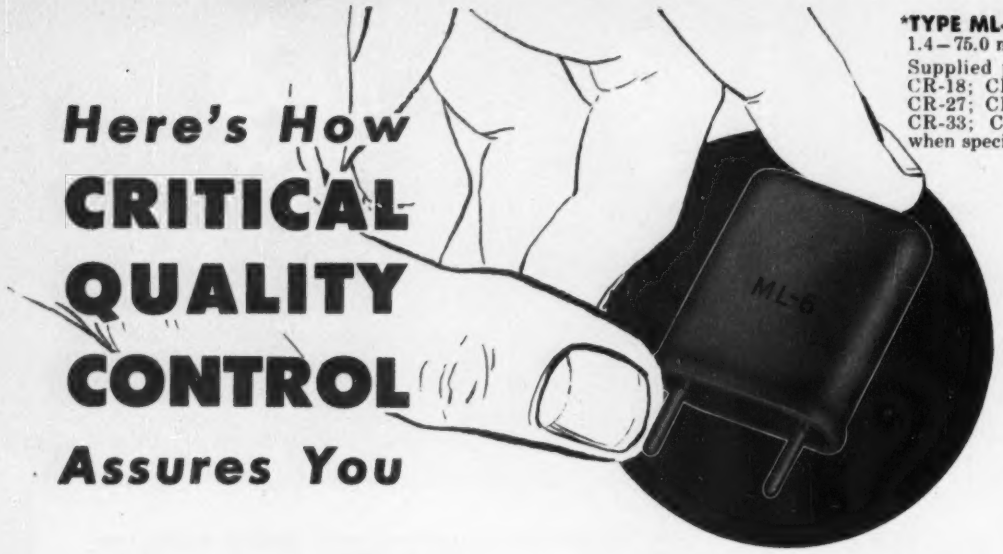
Pictured are typical Tubular Feed-Throughs from 1.00", 21 tubes (1502-21) to 1/8" single tube (1470) and other standard and special designs.

HERMETIC SEAL PRODUCTS CO.

31 South Sixth Street, Newark 7, New Jersey

● FIRST AND FOREMOST IN MINIATURIZATION ●





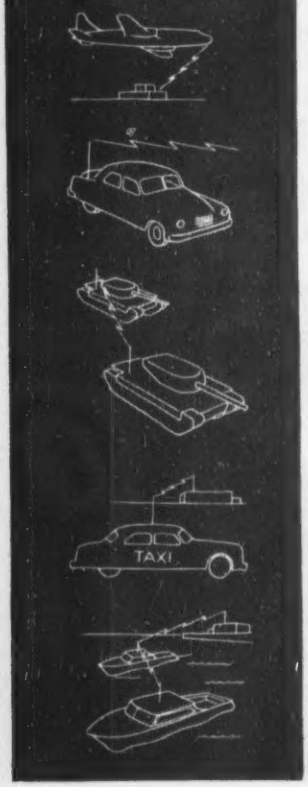
***TYPE ML-6 – RANGE:**
1.4 – 75.0 mc
Supplied per Mil type CR-18; CR-19; CR-23; CR-27; CR-28; CR-32; CR-33; CR-35; CR-36 when specified.

Here's How CRITICAL QUALITY CONTROL *Assures You*

LASTING STABILITY

in Midland CRYSTALS

TOP PERFORMANCE IN EVERY APPLICATION OF 2-WAY RADIO

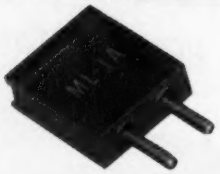


Midland Quality Control is Midland's own system of making sure you get a crystal that takes the beating of extreme heat without excessive drift. Quality control starts with exacting selection of quartz and extends through every step of processing.

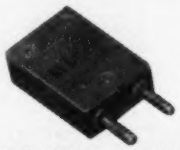
For example, slicing of the crystal is guided by X-ray checks to maintain highest accuracy. Correct angular relationships are strictly maintained. After lapping, X-ray is again used to detect any deviation from precision standards. And finally, after sealing, tests are made again – tests far more punishing than conditions found in actual use.

That's why STABILITY is something you can count on in your Midland crystal – and why Midland quality will give you years of dependable service in every respect.

Whatever your crystal need, conventional or highly specialized . . .



***TYPE ML-1A–RANGE:**
2.0 – 15.0 mc
Supplied per Mil type CR-1A when specified.



***TYPE ML-4 – RANGE:**
1.0 – 10.0 mc
Supplied per Mil type CR-5; CR-6; CR-8; CR-10 when specified.

When It Has to Be EXACTLY RIGHT . . . Contact

Midland MANUFACTURING CO., INC.

3155 Fiberglas Road **Kansas City, Kansas**

Manufacturer of Quartz Crystals for Electronic Frequency Control

Want more information? Use post card on last page.

Speed Nut
SAVINGS STORIES

How SPEED NUT Coil Form Fasteners

Transmit 3-way advantage

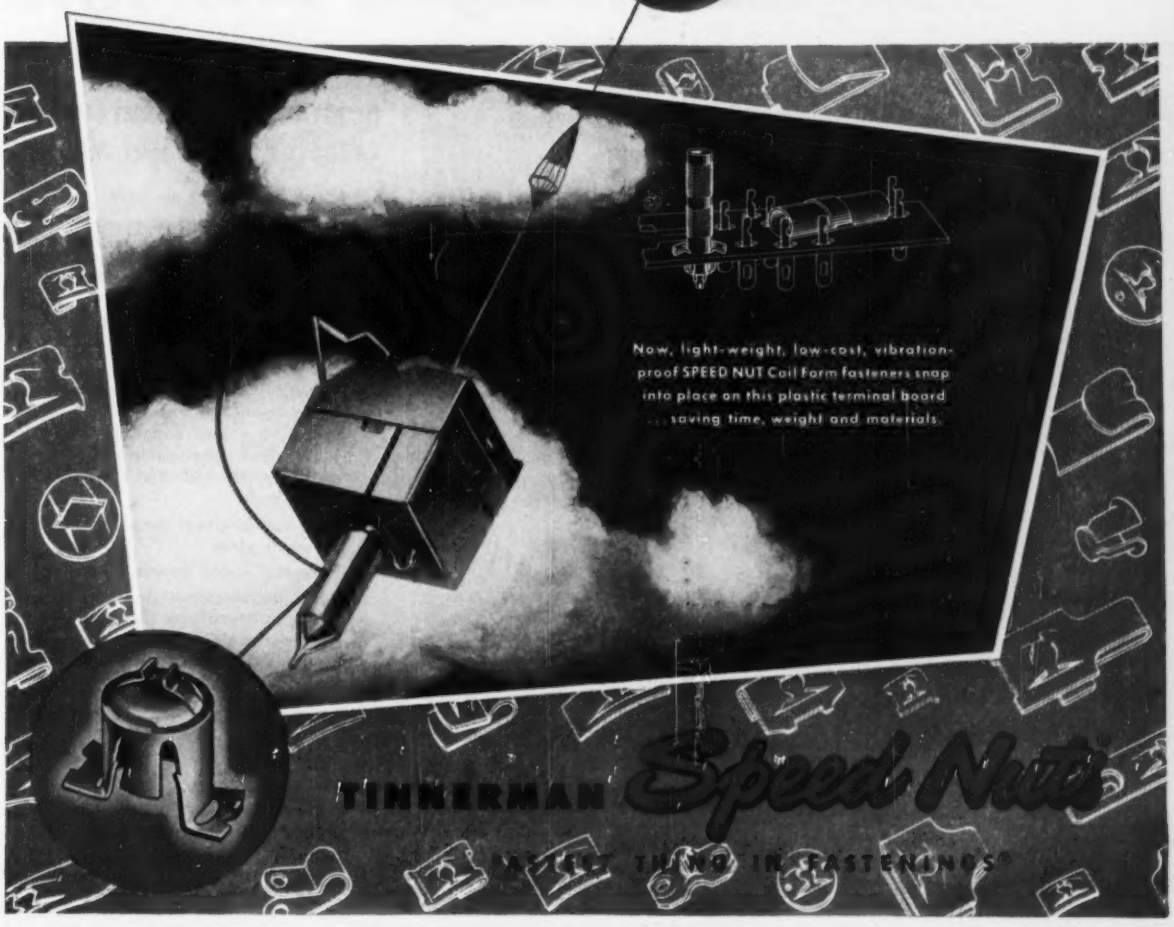
to Weather-Reporting RADIOSONDE

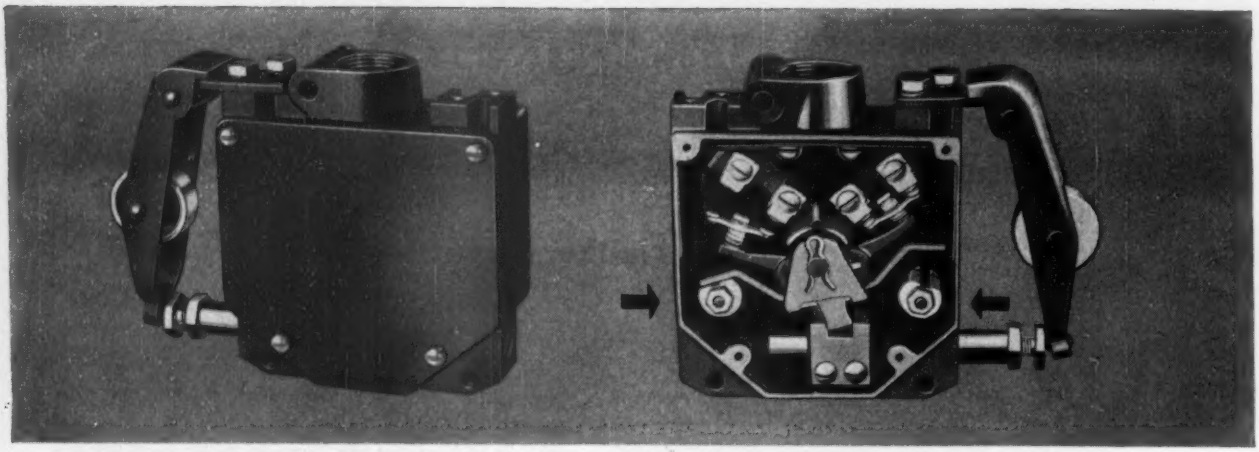
...as told by FRIEZ INSTRUMENT DIVISION of Bendix Aviation Corp., Baltimore, Md.

FRIEZ engineers faced three basic requirements in specifying fasteners for the AN/AMT-4A Radiosonde. First, fasteners had to be *light-weight*, since the device is set free and carried to upper altitudes by balloon. Second, this equipment is expendable, making *economy* a prime factor. And third, because the Radiosonde transmits vital weather data back to the ground, its precise nature demands rigid, *vibration-resistant* fasteners for proper operation. Tinnerman SPEED NUT Coil Form fasteners were selected by Friez after checking many various attaching methods. They more than met the 3-count performance requirement, giving added savings in materials and handling over elaborate machined types.

No matter what your fastening problem, you can rely on a Tinnerman Fastening Analysis to lead the way to production savings. See your Tinnerman representative for details on this free service for your products. And, write today for your copy of SPEED NUT Savings Stories, a booklet of amazing savings to industry: TINNERMAN PRODUCTS, INC., Department 12, Box 6688, Cleveland 1, Ohio.

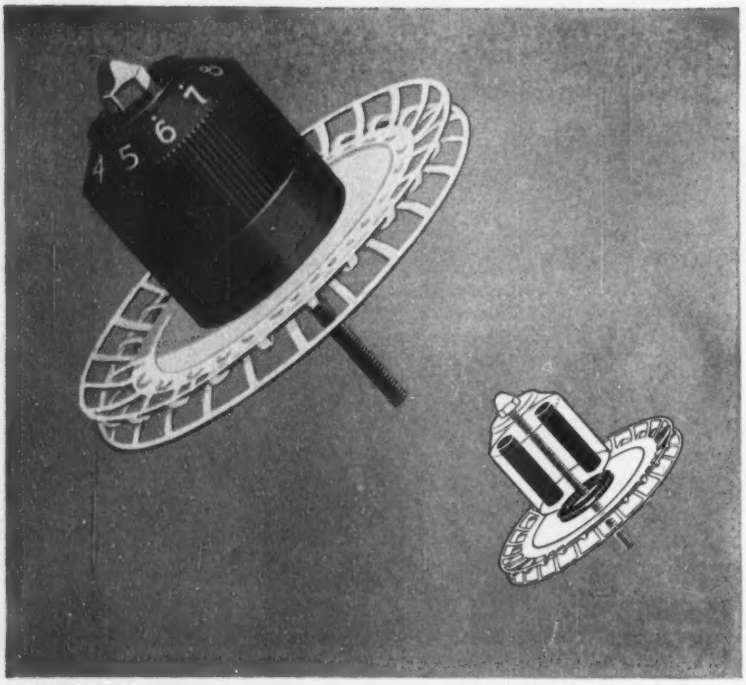
In Canada: Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A.—7 rue Henri Barbusse, Levallois (Seine).


Now, light-weight, low-cost, vibration-proof SPEED NUT Coil Form fasteners snap into place on this plastic terminal board ... saving time, weight and materials.
TINNERMAN Speed Nuts



LIMIT SWITCHES – Even under severe service, this double-break switch will stand up well. Its 2 independent circuits are alternately held open and closed solely by small Carboloy permanent magnets. The magnets assure positive contacts, cleaner breaks without strain or appreciable wear on operating parts, plus a higher degree of accuracy within limits. Also cut down costs of materials, assembly. A typical case of product improvement with Carboloy magnets.

How you can improve controls size, weight, cost with

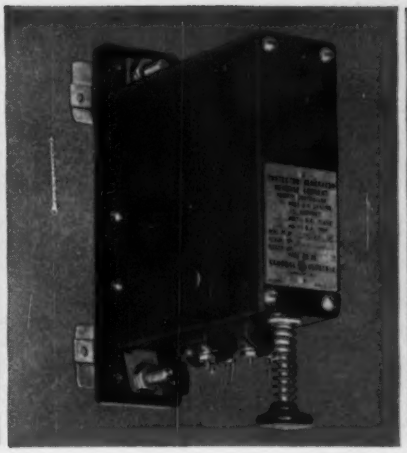


TENSION BRAKES – Three tiny Carboloy permanent magnets are used in this new magnetic brake that controls the winding of yarn and fine fibres. The magnets (shown in cutaway) provide even tension through magnetic drag, cut down on abrasion, slippage, static electricity – give wider tension and speed ranges. Carboloy permanent magnets never need maintenance, never fail.

OUTSTANDING ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

1. Cool – generate no heat
2. Require no electrical energy
3. Cost nothing to operate
4. Eliminate coils, windings, wiring, etc.
5. Need no maintenance – no coils to burn out, no slip rings to clean or replace, etc.
6. Simplify mechanical assemblies – exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication simple
7. Save space–great magnetic strength in small sizes
8. Powerful – and power is constant
9. Combine electrical and mechanical features–transform electrical energy into mechanical motion; mechanical motion into electrical energy
10. No power failures ever
11. Resist moisture – no coils to collect dampness
12. Give uninterrupted operation
13. Create savings – often eliminate costly, power-supplying parts
14. Simple – no operating parts
15. Reduce weight, product size
16. Supply a permanent source of energy

PLUGGING CONTROLS – New device for brakeless stopping of motors features Carboloy magnets. Eddy-current disk rotates in magnetic assembly, creates torque. As motor's speed nears zero with power reversed, torque interrupts circuit, cuts stopping time from 20 seconds to 1 second.



CIRCUIT BREAKERS – Here, a Carboloy magnet assembly simplifies trip element. It eliminates a coil and polarizing connection . . . makes possible reverse-current tripping independent of system voltage. Breaker weighs less, costs less to build, eliminates nuisance trips in circuits.

SNAP SWITCHES – Three reasons Minneapolis-Honeywell uses a Carboloy permanent magnet in this fan control and high-limit switch: 1) It occupies a small space and gives a higher degree of magnetic energy per unit per space. 2) It offers higher stability. 3) The cost is low.

. . . trim down their Carboloy Permanent Magnets

Here are 5 compact controls that now work better, weigh less and cost less to build, thanks to engineering foresight and Carboloy permanent magnets.

Do you manufacture controls or similar devices? If so, chances are excellent that you can profit from Carboloy permanent magnets, too.

For these magnets are simple, self-containing sources of energy that never fail. Powerful in small sizes, they need no external power supply, never require maintenance. They reduce fabrication costs by eliminating wires, coils and operating parts. They let you simplify designs . . . build lighter, smaller, finer-performing products at substantial savings.

Check the controls on these pages. Then check Carboloy magnet engineers. These experts can likely tell you in a hurry just where and how a magnetic assembly can help you. And, of course, they're at your service whenever you want a hand in magnet design and application.

Look to Carboloy production lines, too, for *uniform, high-quality, low-cost* magnets for control equipment—all sizes, all shapes; cast or sintered to your specifications. Mail coupon for free Magnet Design Manual and Standard Stock Catalog.

CARBOLOY
DEPARTMENT OF GENERAL ELECTRIC COMPANY

11139 E. 8 Mile Ave., Detroit 32, Michigan

Plants at Detroit, Michigan; Edmore, Michigan and Schenectady, New York

"Carboloy" is the registered trademark for the products of Carboloy Department of General Electric Company

MAIL COUPON TODAY

CARBOLOY Department of General Electric Company
11139 E. 8 Mile Ave., Detroit 32, Michigan

Sirs:

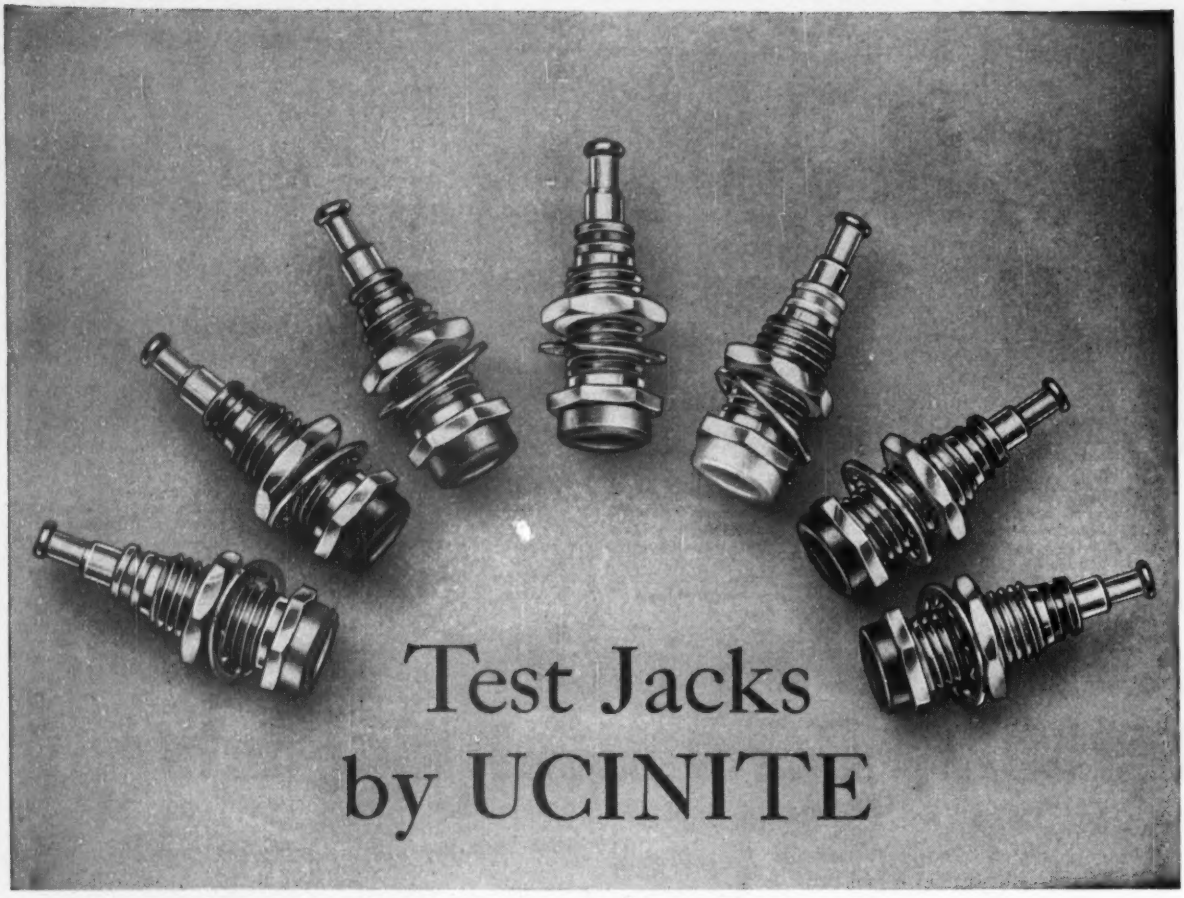
Rush me, without cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

NAME_____ POSITION_____

COMPANY_____

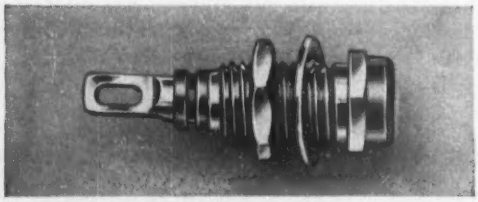
ADDRESS_____

CITY_____ ZONE____ STATE_____

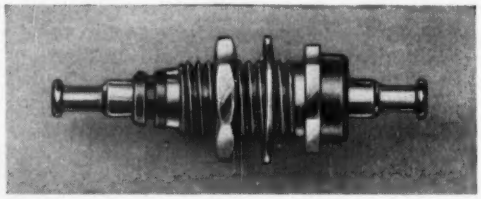


General features of 118930 test jack: Silver-plated, heat-treated beryllium copper contact is made in one piece with large terminal end for easy soldering. Terminal end is tin-dipped. Brass, nickel-plated shell and nut. Metal shell insures firm, dependable mounting. Phosphor bronze lock washer is nickel-plated. Nylon insulator available in different colors: White, black, red, green, brown, orange, blue.

ALSO AVAILABLE



119052. *Same as 118930 but with special milled end with elongated hole for wiring.*



118984. *Feed through type, similar to 118930 but with one-piece brass terminal stud, tin-plated.*

ELECTRICAL ASSEMBLIES Ucinite RADIO AND AUTOMOTIVE

The UCINITE CO.

Newtonville 60, Mass.

Division of United-Carr Fastener Corp.

Specialists in

ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

Want more information? Use post card on last page.

STOP

WASTING TECHNICAL TALENT

Turn over your special fastening problems to *specialists* . . . trained fastener engineers who have been through the trial-and-error stage in this highly specialized field and can free your own engineering staff for finished-product engineering.

It pays. We've proved it . . . for leading manufacturers in the electronics industry . . . and in the automotive, aviation, appliance and furniture industries, too.

United-Carr and its subsidiaries have had years of experience in the design and production of *tailor-made* fasteners and allied devices. Each division of the company provides a reservoir of special knowledge for the others. The result: an integrated organization that makes use of every improvement in materials and methods to produce fasteners that *speed assembly, cut costs* and, in many cases, actually *improve product performance.*

With complete facilities in our own plants for the volume production of special metal stampings and for the assembly of metal to plastic and ceramic components, we are in a position to supply practically any fastening need.

Before bidding on government contracts requiring fasteners or special fastening devices, consult your nearest United-Carr field representative.

UNITED-CARR

MAKERS OF **DOT** *FASTENERS*

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

LABORATORY TEST EQUIPMENT

Unexcelled

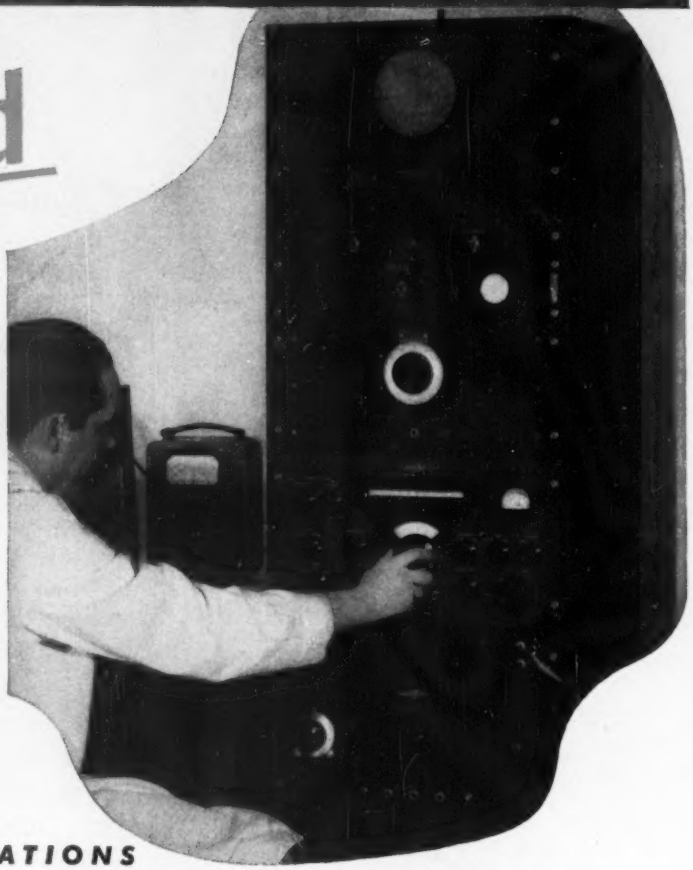
in

★ **Accuracy**

★ **Dependability**

The COLLINS 51J Communications Receiver

The Collins 51J Communications Receiver in addition to its outstanding performance in the communications field, is being widely used in industrial laboratories as a sensitive and accurate measuring instrument and as a spectrum analyzer. Write for complete specifications and details today.



CONDENSED SPECIFICATIONS

FREQUENCY RANGE:
.54 to 30.5 megacycles.

TYPE OF CIRCUIT:
Double Conversion Superheterodyne.

CALIBRATION:
Direct reading in megacycles and kilocycles. One turn of main tuning dial covers 100 kilocycles on all bands.

TUNING:
Linear, divided into 30—one mc bands.

FREQUENCY STABILITY:
Overall stability within 1 kc under normal operating conditions.

SELECTIVITY:
5.5 to 6.5 kilocycles wide at 6 db down. 17 to 20 kilocycles wide at 60 db down.

AUDIO OUTPUT:
4 and 600 ohms impedance. 1 1/2 watts at 1000 cps with less than 15% distortion overall. "S" meter may be switched to read audio output.

RF INPUT:
High impedance single-ended. Break-in relay mounted internally. Antenna trimmer will resonate input circuit when used with any normal antenna.

POWER REQUIREMENTS:
85 watts 45/70 cps, 115 volts or 230 volts by reconnection on power transformer.

DIMENSIONS:
Panel — 10 1/2 inches high, 19 inches wide, notched for rack mounting. Optional metal cabinet — 21 1/8 inches wide, 12 1/4 inches high and 13 1/8 inches deep. Speaker available in metal cabinet 15 inches wide, 10 5/8 inches high and 9 1/8 inches deep.

For excellence in radio communications equipment, it's . . .

COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

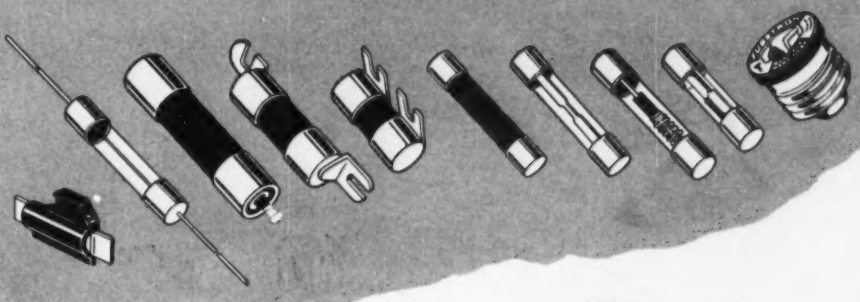
11 W. 42nd St., NEW YORK 36 **1930 Hi-Line Drive, DALLAS 2** **2700 W. Olive Ave., BURBANK**

Want more information? Use post card on last page.

WHATEVER YOUR FUSE NEEDS THIS ONE SOURCE SAVES TIME AND TROUBLE

BUSS FUSES

for TELEVISION...RADIO...RADAR INSTRUMENTS...CONTROLS...AVIONICS



From fractional amperage types to huge industrial fuses, BUSS has specialized in a complete fuse line for the past 39 years. Whatever your circuit protection problem, you can choose from this complete line not only with convenience but with confidence in the unequalled BUSS reputation for quality and dependability.

Evidence of BUSS dependability is the rigid electronic testing every fuse must undergo before leaving the factory. Ultra-sensitive electronic devices check it to exacting standards of construction, calibration and physical dimension.

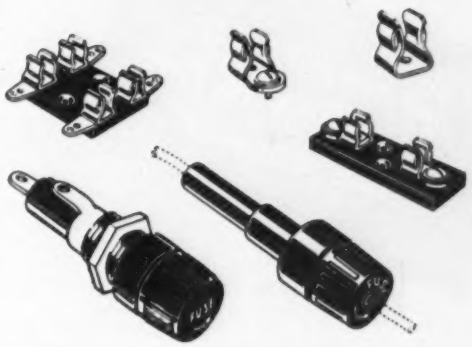
When you install BUSS Fuses you can forget about fuse troubles yet you can be certain of positive protection.

Turn To BUSS Engineers With Your Fuse Problems.

They will be glad to assist you in selecting the fuse to do the job best . . . and if possible a fuse that will be available from local wholesaler's stocks.

...Plus

A COMPLETE LINE OF FUSE CLIPS, BLOCKS AND HOLDERS



USE THE HANDY COUPON—*It's just good business to rely on BUSS FUSES*

BUSSMANN Mfg. Co. (Division of McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

*Name*_____

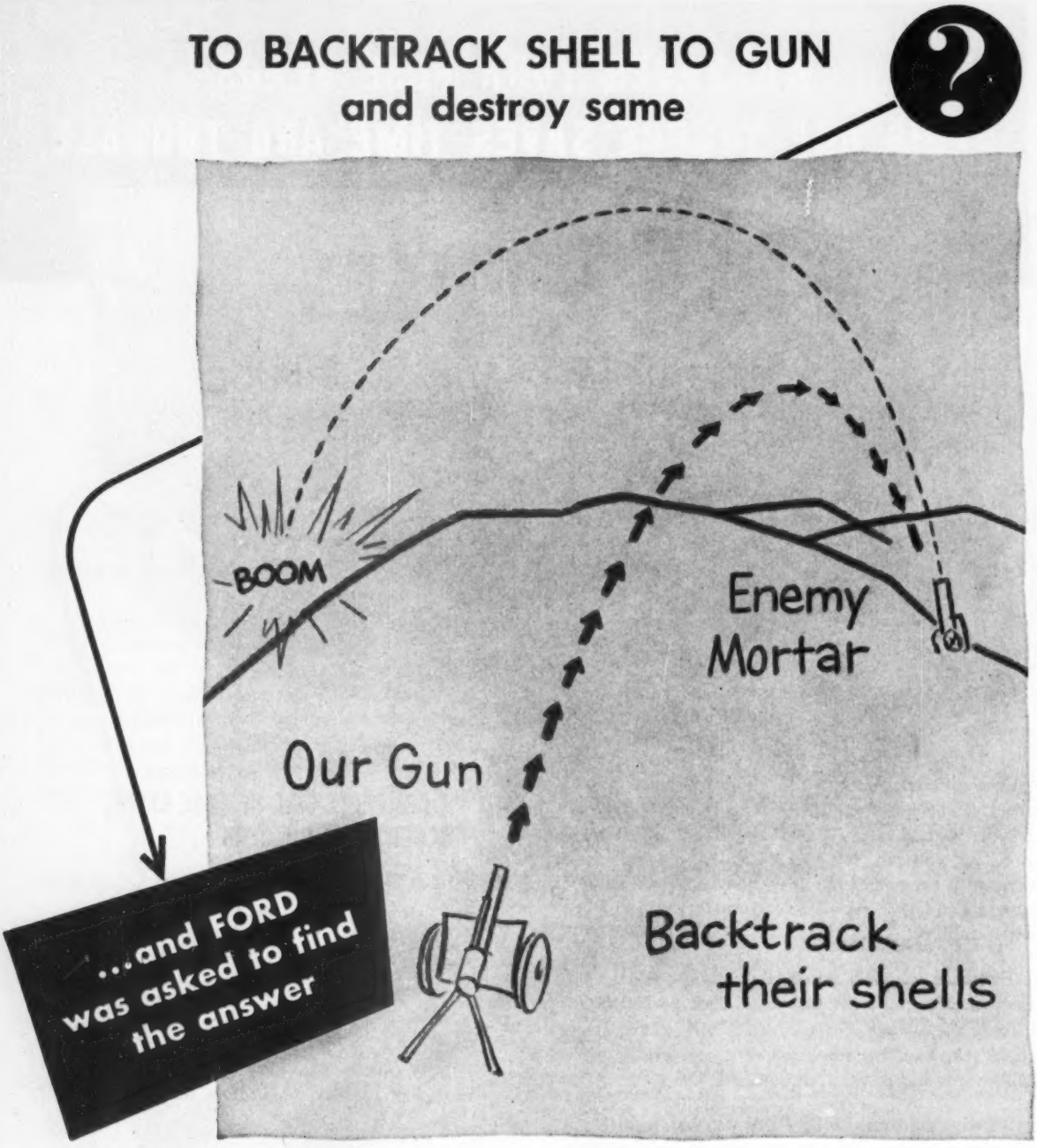
*Title*_____

*Company*_____

*Address*_____

*City & Zone*_____ *State*_____ ELRC-253

TO BACKTRACK SHELL TO GUN
and destroy same



Can projectiles be "seen" approaching and their flight backtracked to locate the mortar or gun that fires them? This problem was simply reconciled with special computing equipment designed to be built right into the gun. The engineering of such a computer, the handling of such ballistic data, all falls into the pattern of previous Ford achievements.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.

6

You can see why a job with Ford Instrument Company offers a challenge to young engineers. If you qualify, there may be a spot for you in automatic control development at Ford. Write for illustrated brochure.

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

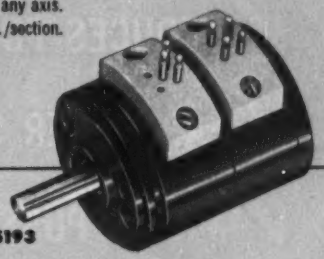
TRULY independent screwdriver Vernier Phasing

MODEL 85194

Self-locking screwdriver-actuated phasing adjustment. Each section easily adjusted to maximum resolution (one wire) in ±11° range. 2⅛" diameter; ¼" shaft; 2,000 to 300,000 ohms per section; 4 watts @ 25° C; 1 to 6 sections; body length 4.8" max.

SPECIFICATIONS

RESISTANCE: 2,000 to 300,000 ohms/section (±5%).
LINEARITY: ± 0.3% of total resistance.
POWER RATING: 4 watts per section at +25°C ambient.
ELECTRICAL CONTACT ANGLE: 356° standard. (Any winding angle up to 360° on order).
MECHANICAL SHAFT ROTATION: 360° continuous.
TORQUE: Starting torque for 6-section unit: 1.2 oz.-in.
TEMPERATURE RATING: Operating range from −55°C to +71°C ambient.
ACCELERATION: Will function during acceleration of 50G, applied along any axis.
WEIGHT: 4 oz./section.



MODEL 85193

Compact-rugged-accurate. A smaller version of the GANGPOT without the phasing feature. Diameter 1⅛"; ¼" shaft; aluminum housing; 500 to 70,000 ohms per section; 1 to 6 sections; body length 3.5" max.; dual mounting; linear or non-linear windings up to 360° available.

SPECIFICATIONS

RESISTANCE: 500 to 70,000 ohms/section (±5%).
LINEARITY: ±0.5% of total resistance.
POWER RATING: 2 watts per section at +25°C ambient.
ELECTRICAL CONTACT ANGLE: 354° standard (Any winding up to 360° on order), with the brush non-shorting.
MECHANICAL SHAFT ROTATION: 360° continuous.
TORQUE: Starting: less than 0.6 oz.-in. for a 6-section unit.
TEMPERATURE RATING: Operating range from −54°C to +71°C ambient.
ACCELERATION: Will function during acceleration of 50G, applied along any axis.
WEIGHT: 1 oz. per section.

For modifications of standard specifications, please forward requirements.

Specifically designed and built to performance standards far beyond present concepts of potentiometer design, GANGPOT Instrument-Quality potentiometers are ready to solve multiple potentiometer problems. Rugged, aluminum-housed units with low torque, high performance, and long-life accuracy, GANGPOTS are presented in two sizes to fill all requirements. GANGPOT EXTRAS include solid, stainless steel shafts, toroidally wound coils for up to 360° windings, shielded ball bearings, syncro or screw type mounting, and adaptability to non-linear functional windings. Built without any bulky external bolts, clamps or rings, the GANGPOTS lend themselves to an unsurpassed versatility of design applications.

For catalog and engineering data on these and other fine instruments write:

Giannini INSTRUMENT QUALITY POTENTIOMETERS

G. M. GIANNINI & CO. INC., PASADENA 1, CALIFORNIA — EAST ORANGE, NEW JERSEY

Unique PHELPS DODGE development

DRASTICALLY CUTS

- ✓ FAST WIRE-TO-WIRE BONDING INTO RIGID COIL.
- ✓ REDUCES FORMING AND ASSEMBLY OPERATIONS.
- ✓ FAR FEWER STEPS IN WINDING TYPICAL TV YOKE COIL.
- ✓ MAKES POSSIBLE UNUSUAL SHAPE COILS.

"Bobbin-less" coil

Fly-back coil

TV yoke coil

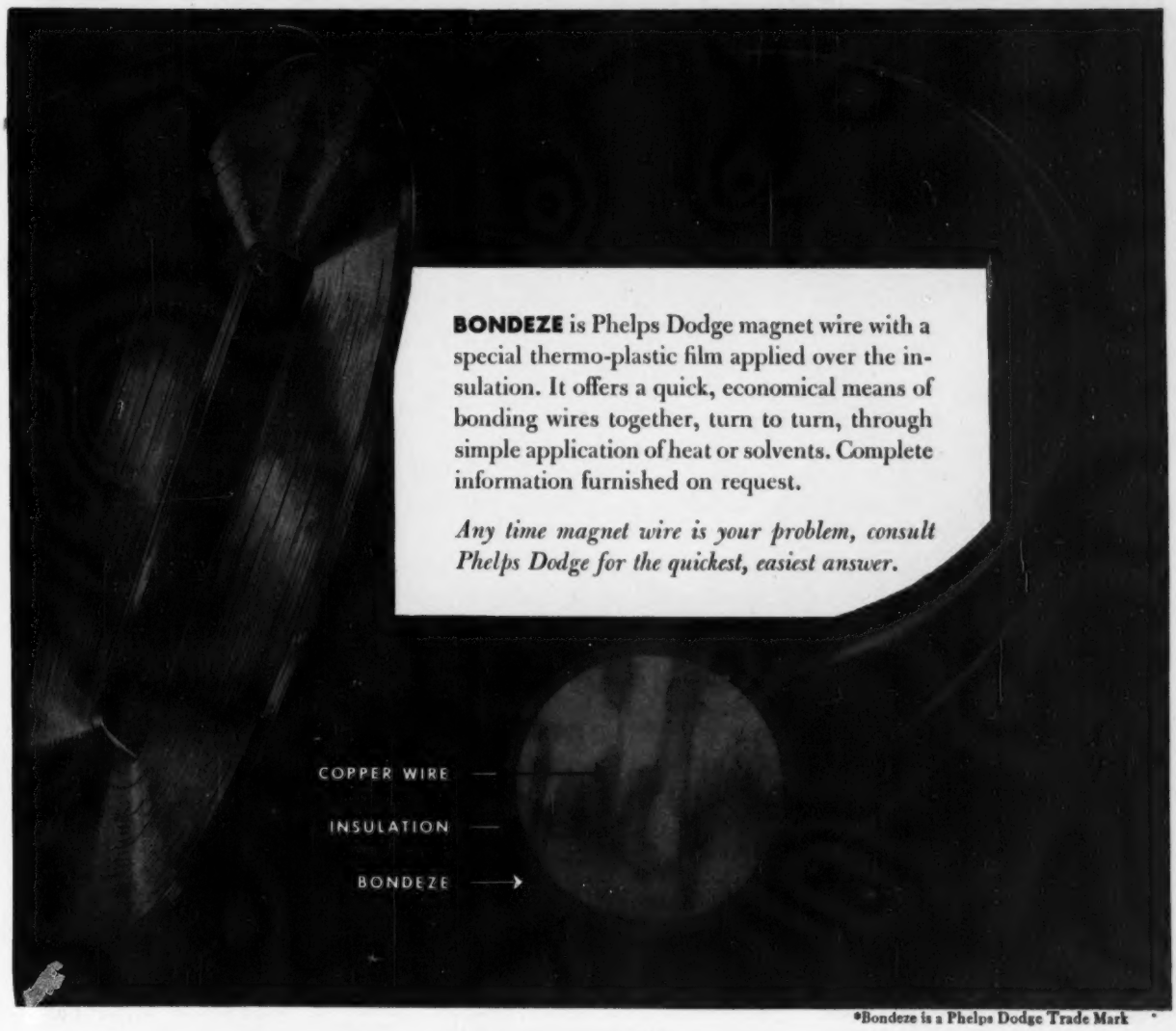
Hoop-shaped coil

"It takes the best

PHELPS DODGE COPPER PRODUCTS CORPORATION

*in Magnet Wire--BONDEZE**...

COIL WINDING COSTS!



BONDEZE is Phelps Dodge magnet wire with a special thermo-plastic film applied over the insulation. It offers a quick, economical means of bonding wires together, turn to turn, through simple application of heat or solvents. Complete information furnished on request.

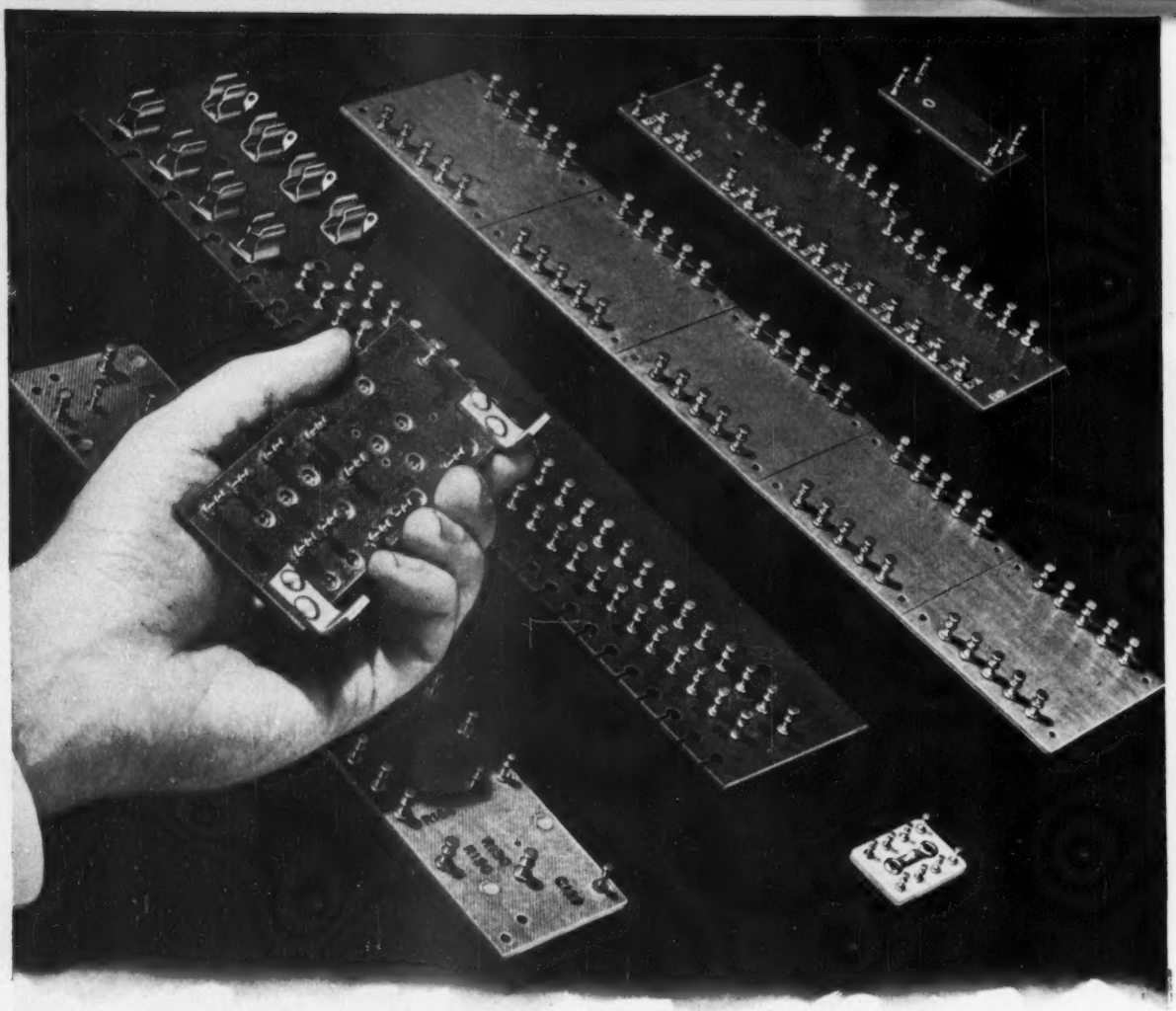
Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer.

*Bondeze is a Phelps Dodge Trade Mark

to make the best!"

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA



Name your needs in terminal boards ...we'll meet them accurately

The rigid specifications of government agencies and the armed forces need pose no problem to you. C.T.C. is in an excellent position to handle government sub-contracts for electronic parts and assemblies.

Our Custom Engineering Service is constantly supplying special terminal boards to the top names in electronics. These boards are built to severe government specifications, are fabricated of certified materials to fit the job. Among the specifications involved are: MIL-P-3115A, MIL-P-15037, MIL-P-15035A, MIL-P-15047, MIL-P-997A.

Boards can be made of cloth, paper, nylon or glass laminates (phenolic, melamine or silicone resin), and can be lacquered or varnished to specifications: JAN-C-173 and JAN-T-152. Lettering and numbering is done by rubber stamping, silk screening, hot stamping, engraving. Inks used in rubber stamping contain anti-fungus and fluorescent additives.

Terminals, feed-throughs, mounting hardware and all other terminal board fixtures meet all applicable government specifications.

Standard "All Set" Boards, scribed for easy separation, for the assembly line and laboratory are available in cotton fabric phenolic per specification MIL-P-15035A and in nylon phenolic per MIL-P-15047A.

For complete information write: Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers, contact: E. V. Roberts, 5068 W. Washington Blvd., Los Angeles 16, or 988 Market St., San Francisco, Cal.

custom or standard... the guaranteed components

CTC

See us at Booth 287, IRE Show

453 439 456

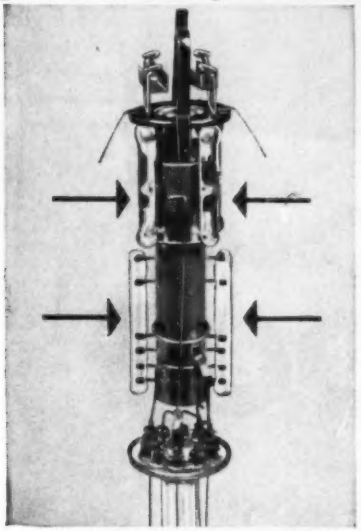
Want more information? Use post card on last page.

Two 21-inch Metal Cone Picture Tubes Announced by Westinghouse

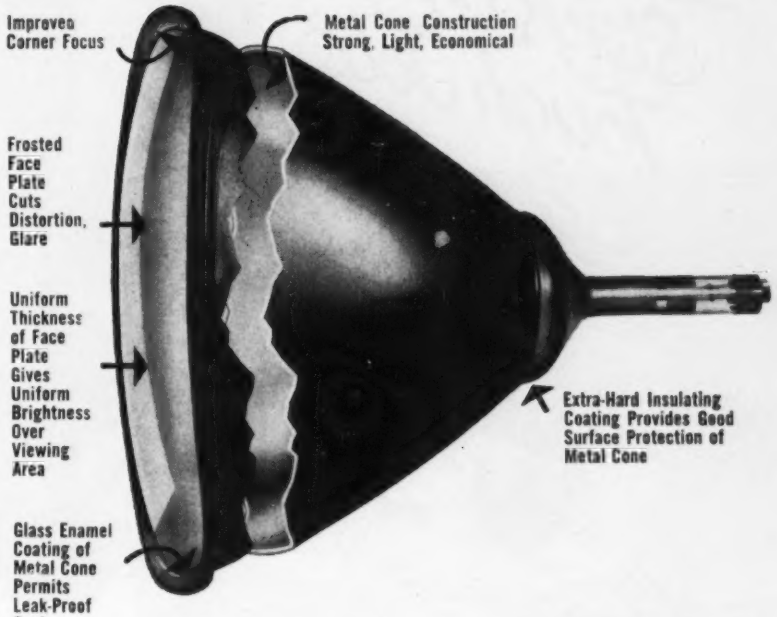
21AP4 and 21MP4 now available for immediate delivery

Manufacturers faced with problems of handling, cost and uniformity in large picture tubes now may order Westinghouse 21-Inch RELIATRON™ Metal Cone Picture Tubes for immediate delivery. The new tubes—almost 33⅓% lighter in weight—are manufactured under the most rigid quality control system in the country.

Superior face plate quality assures greater freedom from blemishes and glass imperfections. Uniform face plate thickness greatly reduces optical distortion over the viewing area. The etched glass of the face plate eliminates glare from external light sources.



Improved Gun Employs Glass Beads. Westinghouse makes the new metal cone electrostatic focus tube with glass-beaded assembly. This assures accurate element spacing within close tolerances to improve spot size and picture uniformity.


Improved Corner Focus
Metal Cone Construction Strong, Light, Economical
Frosted Face Plate Cuts Distortion, Glare
Uniform Thickness of Face Plate Gives Uniform Brightness Over Viewing Area
Extra-Hard Insulating Coating Provides Good Surface Protection of Metal Cone
Glass Enamel Coating of Metal Cone Permits Leak-Proof Seal

The 21-Inch RELIATRON Picture Tubes feature still another important improvement. The face plate is sealed to the metal cone using an intermediate glass-enamel frit.

PRODUCTION SAVINGS

The 21-Inch RELIATRON Picture Tubes introduce new economies throughout TV set production. Their lighter weight cuts shipping costs. The 21MP4 tube is electrostatically focused, requiring no focusing coil or focusing magnet. The 21AP4 is designed for magnetically focused operation.

Metal cone tubes give increased mechanical strength, and because of their light weight are easier to handle and assemble in TV receivers.

BETTER PICTURES

Metal cone picture tubes permit the use of spherical face plates of uniform thickness that allow receiver manufacturers to use standard available deflection components that produce pictures of consistently high quality.

Employment of the Westinghouse 21-Inch RELIATRON Metal Cone Picture Tubes enables you to meet the growing demand for larger screen TV receivers, to deliver a better picture, and at the same time, to realize important savings in your production operations.

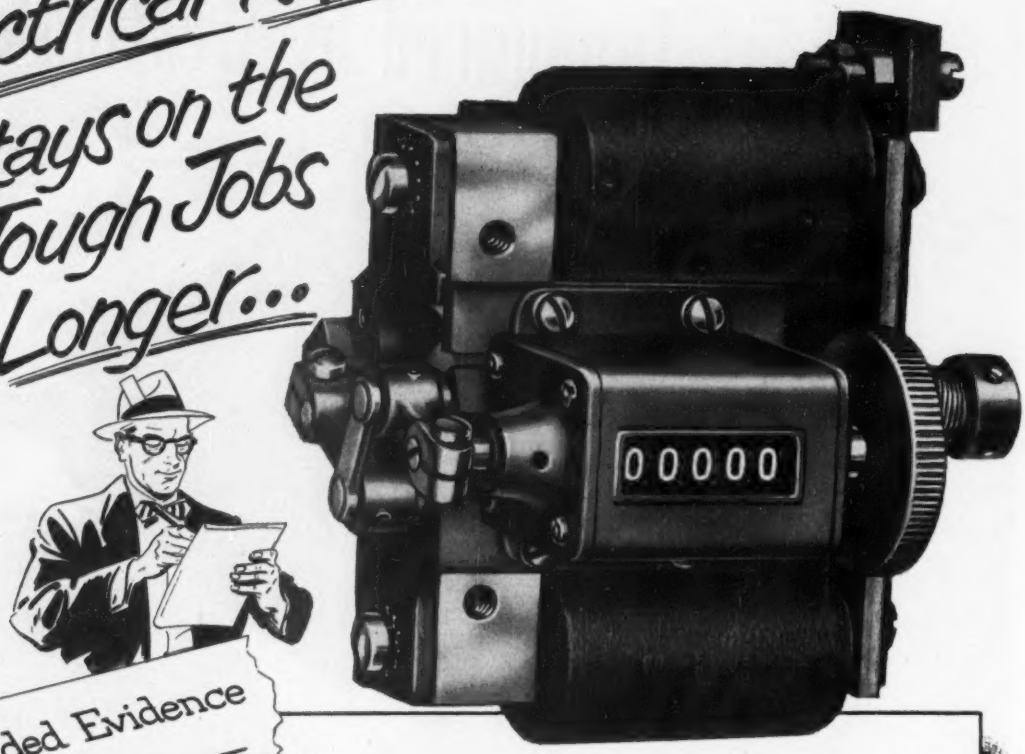
The new RELIATRON metal cone tubes now are available in quantities which permit immediate delivery of production-size orders. For complete details, write Dept. A-202.

YOU CAN BE SURE... IF IT'S Westinghouse

RELIATRON™ TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.

This Electrical Reporter Stays on the Tough Jobs Longer...



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Compact and rugged . . . this electrically operated reset counter is specially designed for tough jobs that demand longer counter life.

Here's another instance of the *infinite applicability* of Veeder-Root *Count*rol — electrical, mechanical or manual. And here's another instance, too, of the endless resourcefulness of Veeder-Root engineering, and the ability to design a *complete counting package* that fits the job fully and exactly. Now . . . what's *your* problem?

VEEDER-ROOT INCORPORATED

"The Name That Counts"

HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N.Y. • Greenville, S.C
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Offices and Agents in Principal Cities

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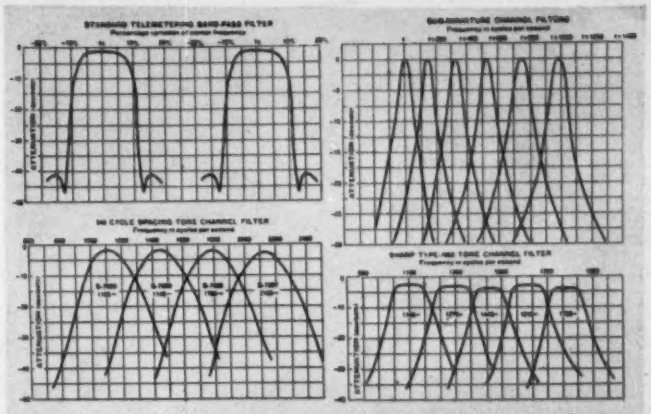
EXPANDING PRODUCTION
in Toroids & Coils

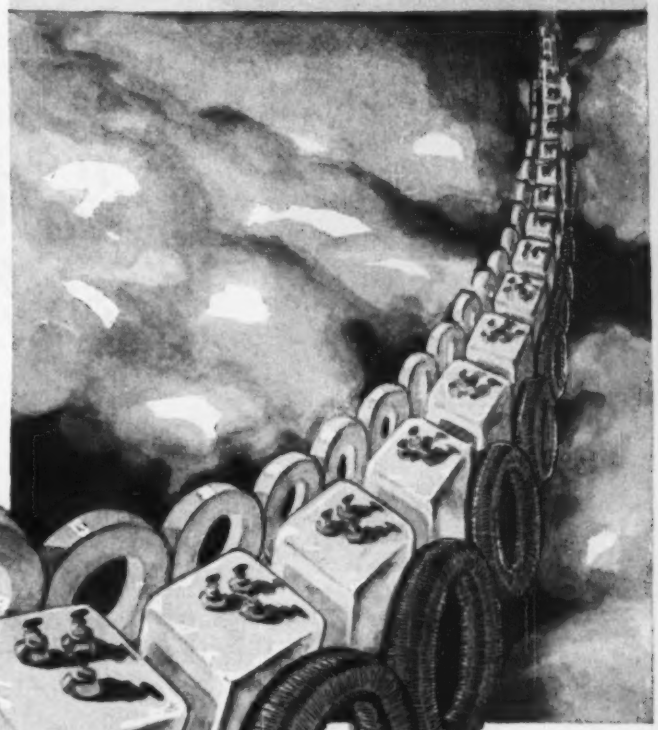


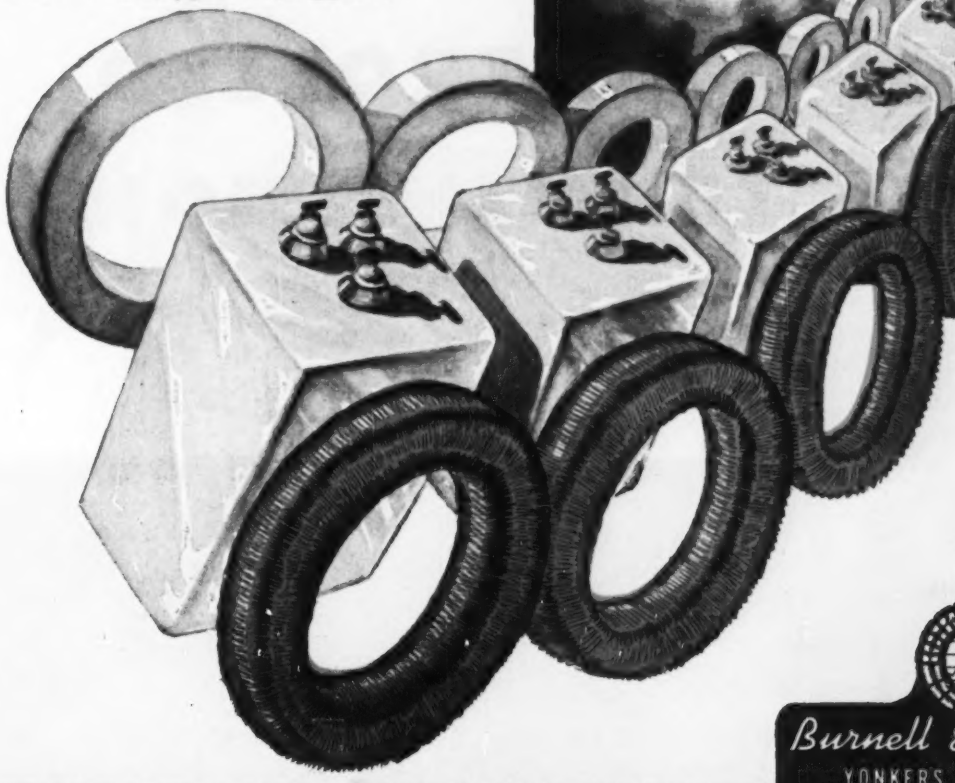
At every management meeting in Burnell & Company there is an unseen but highly respected visitor. He is the spectre of all our customers and his opinions carry weight. Recently he suggested that in addition to our other expansion measures that we must find a way to improve deliveries for emergency and special sample orders. Our solution is certainly not original but no less effective.

Burnell & Company's new sample department has been able to produce audio filters from proverbial 'scratch' to the customer's waiting hands in as little as ten days!

Frankly, this cannot always be accomplished but our average has been ranging between three to four weeks for emergency samples and four to six weeks for regular prototypes instead of the former twelve weeks of the pre-sample department days.

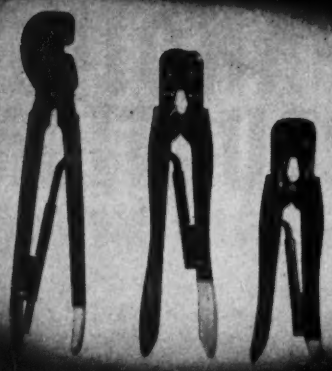
Adding this to our new winding department and our new testing and finishing departments the sum total has been a *still* better product at a better delivery than ever before.





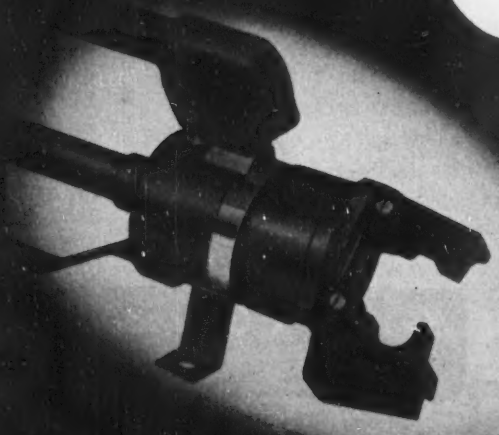
Burnell & Company
YONKERS 2, NEW YORK

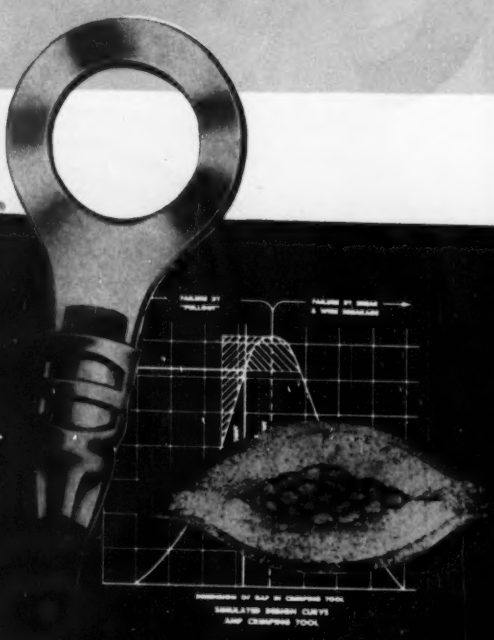
EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

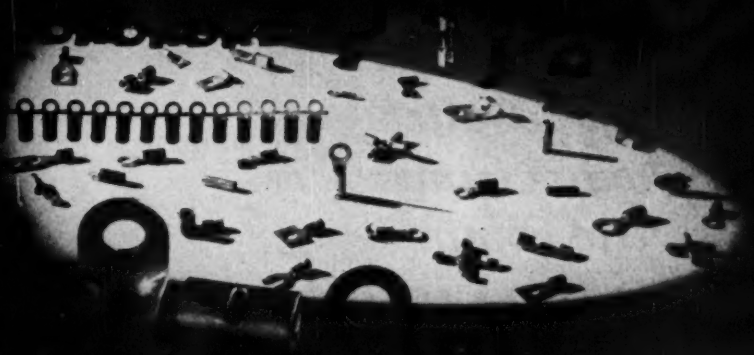


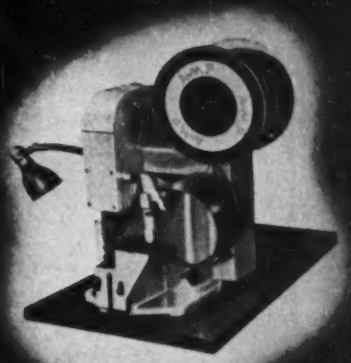
it's the Extra Factor of Assurance that counts...

A-MP CONTROLLED WIRE TERMINATION



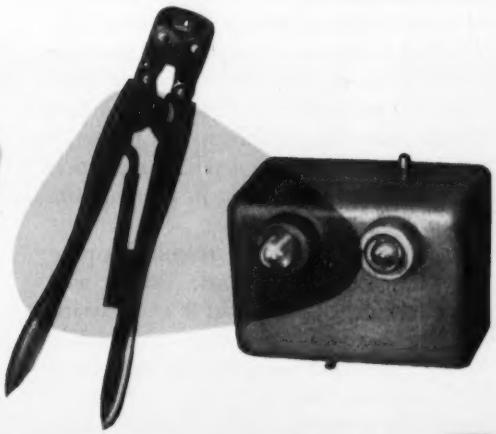




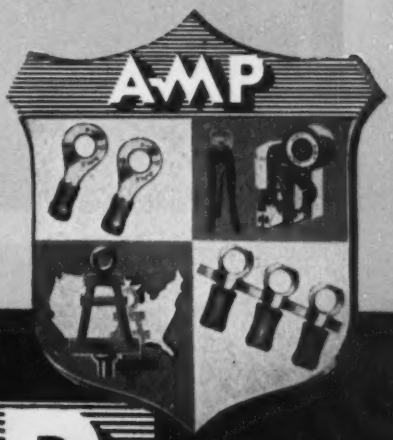


All the gadgets or combination tools in the world will not insure the correct installation of your wire terminations day in, day out, on the line. It's the extra factor of assurance that counts! AMP tools and terminals are made to use together. They're made so that you can be *sure* that you have a correctly installed termination. AMP application tools and dies and automatic machines are so designed that at the point of application you can control accuracy and uniformity within $\pm .003''$. Remember: In wire termination there is no short cut to precision and foolproof production!

Shown below: AMP CERTI-CRIMP* hand tools—will not release until proper crimping pressure has been reached. (Below right) the AMP INSPECTO-MASTER* gives continuous inspection at point of terminal application. Write to AMP for information about these and other recent developments in wire termination.



YOU CAN
COUNT ON
AMP



AMP

AIRCRAFT-MARINE PRODUCTS, INC.

2100 Paxton Street, Harrisburg, Pa.

Canadian representative:
1553 Eglinton Ave. West Office 1-A Toronto, Ontario

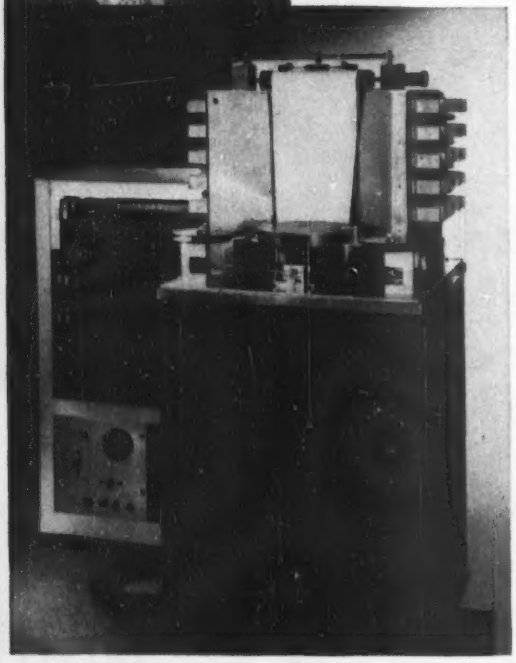
AMP Trade-Mark Reg. U.S. Pat. Off.

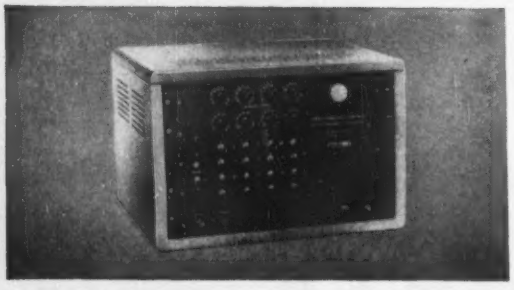
*Trade-Mark

Potter Instrument Company, Inc.

"The 'Flying Typewriter' and all electronic counters require electric components that are rugged and reliable"

says Jack Leight, Sales Engineer,
Ward Leonard Electric Company, Mount Vernon, New York





The "Flying Typewriter" is a revolutionary new high-speed electronic printer for data handling, communications, and computing. Developed by the Potter Instrument Company, Inc., Great Neck, New York, it is capable of printing 24,000 characters a minute "on the fly" from a continuously revolving type wheel.

Coupled to an electronic storage or memory unit, the machine first interprets, then prints in familiar typed lines, information taken in coded form from magnetic tape and punched cards or transmitted over narrow channel radio link, telephone and telegraph lines. The entire alphabet, numerals, punctuation and other special symbols are used in printing 300 lines per minute.

Such speed and accuracy in a machine require reliable, rugged electric components. That is why the Potter Instrument Company uses Ward Leonard VITROHM resistors and relays in the electronic counters for the "Flying Typewriter" as well as in many other types of high-speed electronic counters.

The trouble-free operation of Ward Leonard controls also eliminates many costly and time-consuming repairs.

Ward Leonard is always ready to put its staff of application engineers to work with you.

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK
Result-Engineered Controls Since 1892

Special alloy resistance wire is being wound on Vitrohm cores by Caroline Jervisa, for 17 years an employee of the company.

Skilled operators spot weld terminals to Vitrohm resistor ceramic cores. Welding assures permanent anchorage to the cores.

Long service life of VITROHM resistors results from unified manufacture, uniform quality, matched thermal characteristics

VITROHM resistors stay on the job under the most adverse operating conditions such as those to which they are subjected in electronic counters where less carefully made resistors would break down.

Thermal shock, vibration, corrosive atmosphere, overloads, even prolonged exposure to humidity and electrolysis will not affect their performance. All parts are uniform in quality, balanced in respect to thermal coefficient of expansion.

All Ward Leonard controls are made to exacting specifications, are guaranteed to give dependable service.

Consult Ward Leonard on their complete line of resistors, relays, rheostats, and other electric controls to meet your special needs.

O.D. and concentricity of finished ceramic cores is checked by Minna M. Henderson, who has had 12 years experience with Ward Leonard.

Prior to firing, tubular ceramic cores are being cut to exact size by Ann Trotta. A continuous check is made to maintain close dimensional tolerances.

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EXPORT

New York 4, N. Y.	Ad. Auriema, Inc.

Model No. 511
Price: $345.00

Versatile New Alphatron VACUUM GAUGE...

NEW LOW COST—WIDER RANGE

BATTERY OPERATION eliminates expensive power supply, improves accuracy and stability by removing variables of line voltage and power supply.

1000 TO 0.0001 mm HG READINGS. Wider range than previous models. Full scale deflections at 1000, 100, 10, 1, 0.1 and .01 mm HG absolute. All scales linear.

QUICK START. Only a few seconds warm-up time required. Convenient "on-off" operation saves batteries. Special switch permits instant check of battery condition on meter.

PERMANENT ACCURACY of ± 2% full scale. Long half-life ionization source insures permanent maintenance of original factory calibration.

INSTANT RESPONSE. Tracks pressure fluctuations with negligible time lag.

SMALL VOLUME. Net addition to your vacuum system about 50 cc.

SMALL, LIGHT, PORTABLE. As convenient to use as it is accurate and dependable. Write for more information.

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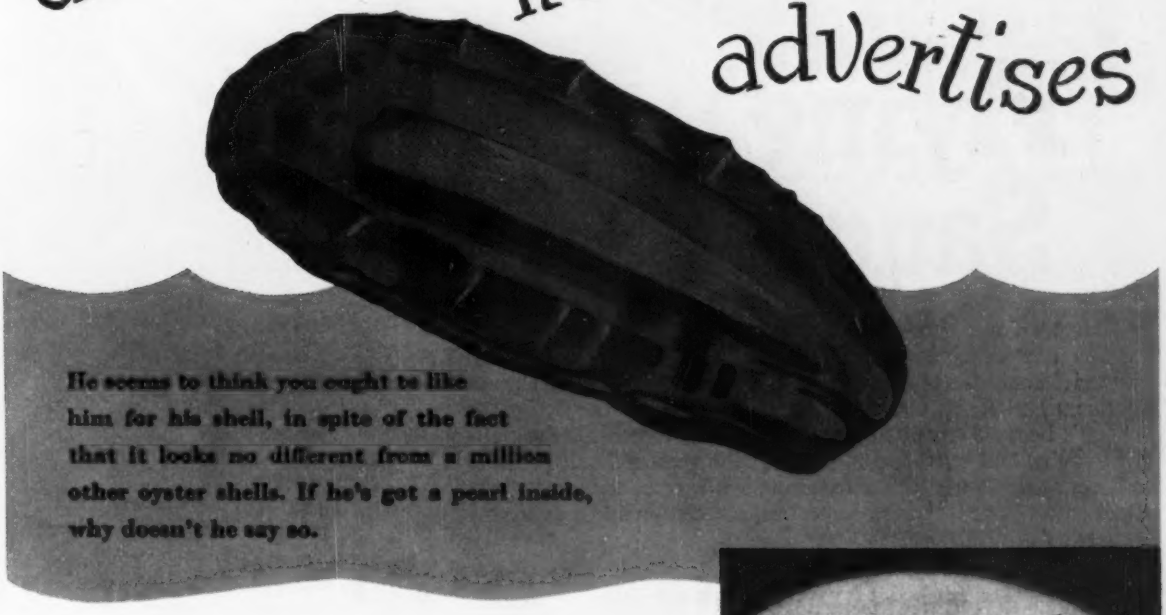
National Research Corporation

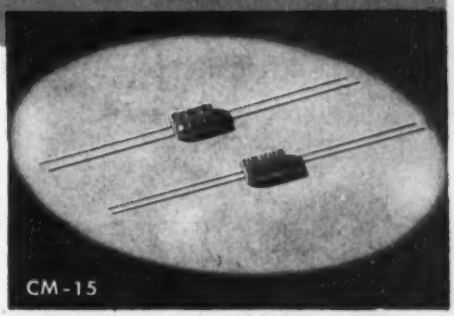
EQUIPMENT DIVISION

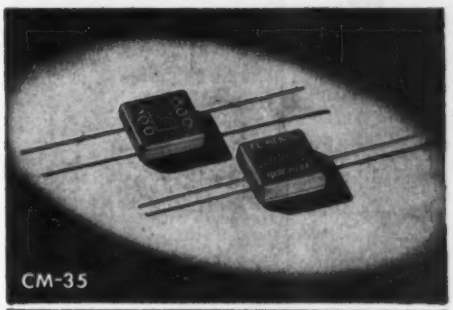
Seventy Memorial Drive, Cambridge, Massachusetts

an oyster never advertises



He seems to think you ought to like him for his shell, in spite of the fact that it looks no different from a million other oyster shells. If he's got a pearl inside, why doesn't he say so.





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Write on business letterhead for catalog and samples.

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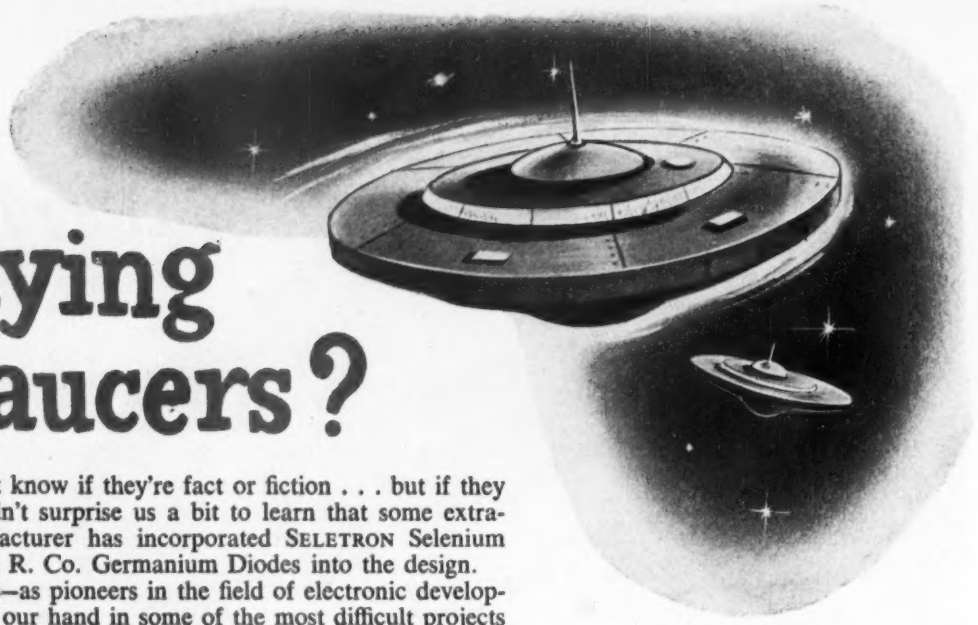


Flying Saucers?

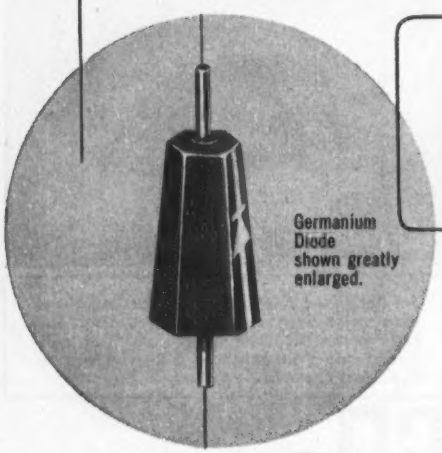
Frankly we don't know if they're fact or fiction . . . but if they *are* fact it wouldn't surprise us a bit to learn that some extra-terrestrial manufacturer has incorporated SELETRON Selenium Rectifiers and R. R. Co. Germanium Diodes into the design.

That's because—as pioneers in the field of electronic development—we've had our hand in some of the most difficult projects and met some of the stiffest requirements ever cooked up! Making drawing board dreams come true are daily chores at Radio Receptor Co.!

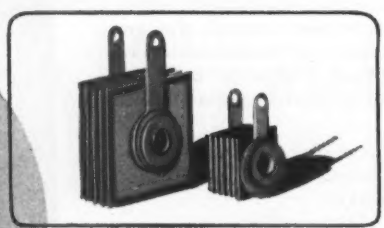
Seletron

GERMANIUM DIODES

Radio Receptor's new Germanium Diodes feature polarity at a glance combined with simplicity of construction and sound design principles. The tapered shape speeds assembly because operators can see at a glance the correct direction of assembly. Users are enthusiastic over the quality of the product which is currently being used in walkie-talkies, computers, TV sets, tuners and other electronic applications.



Germanium Diode shown greatly enlarged.



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Seletron Selenium Rectifiers, in both miniature and industrial types, are in constant demand by an increasingly large number of engineers throughout the world because they are completely dependable under the most grueling conditions. Years of experience have given Radio Receptor Co. a deep insight into the idiosyncrasies of rectification.

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PART NO.	A	B	C	D	E	F	G	H	J
D-3342	1 1/32	.490	3/8	.095	3/16	3/16	1/2	1/16	3/32
D-3346	1 19/32	5/8	.490	.095	1/4	3/8	7/8	3/32	1/8
D-3350	2 9/32	15/16	11/16	.130	3/8	3/8	1 15/32	1/8	1/8
D-3349	3 3/16	3/4	9/16	.130	1/4	5/16	2 7/16	1/8	1/8

STANDARD THREADED STUD TYPES

PART NO.	A	B	C	D	E	F	G	H	J	K
D-3856	1 7/32	.490	3/8	1/16	1/4	3/16	1/2	1/16	3/32	6/32
D-3857	1 51/64	5/8	.490	1/16	1/4	3/8	7/8	3/32	1/8	6/32
D-3962	2 15/32	15/16	11/16	.055	3/8	3/8	1 15/32	1/8	1/8	8/32
D-3638	2 15/32	15/16	11/16	1/16	3/8	3/8	1 15/32	1/8	1/8	10/32

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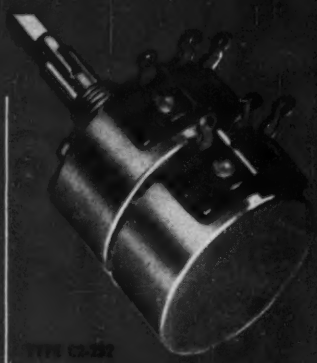

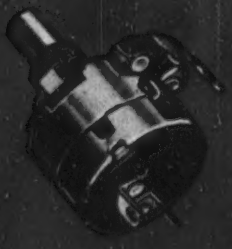

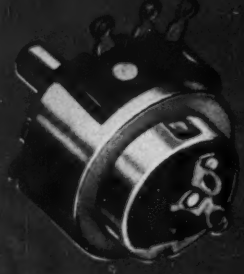

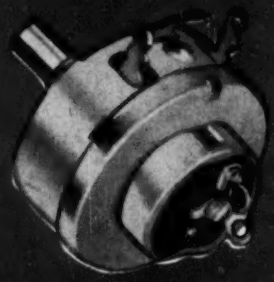

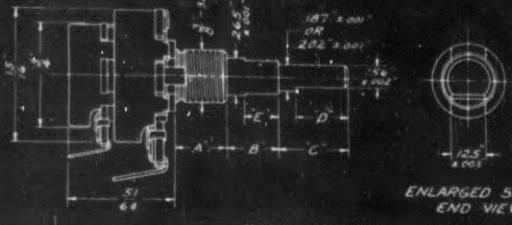

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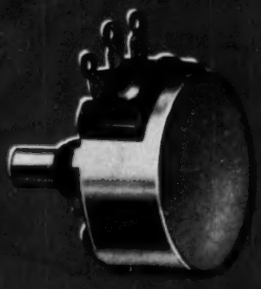

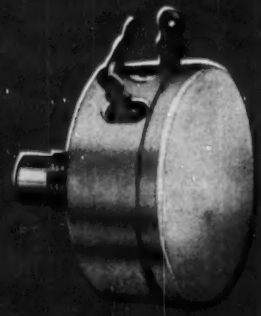

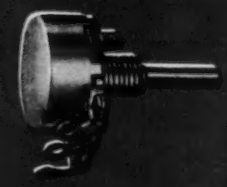

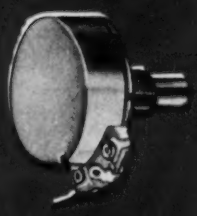

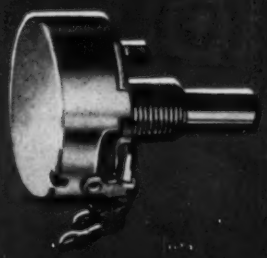

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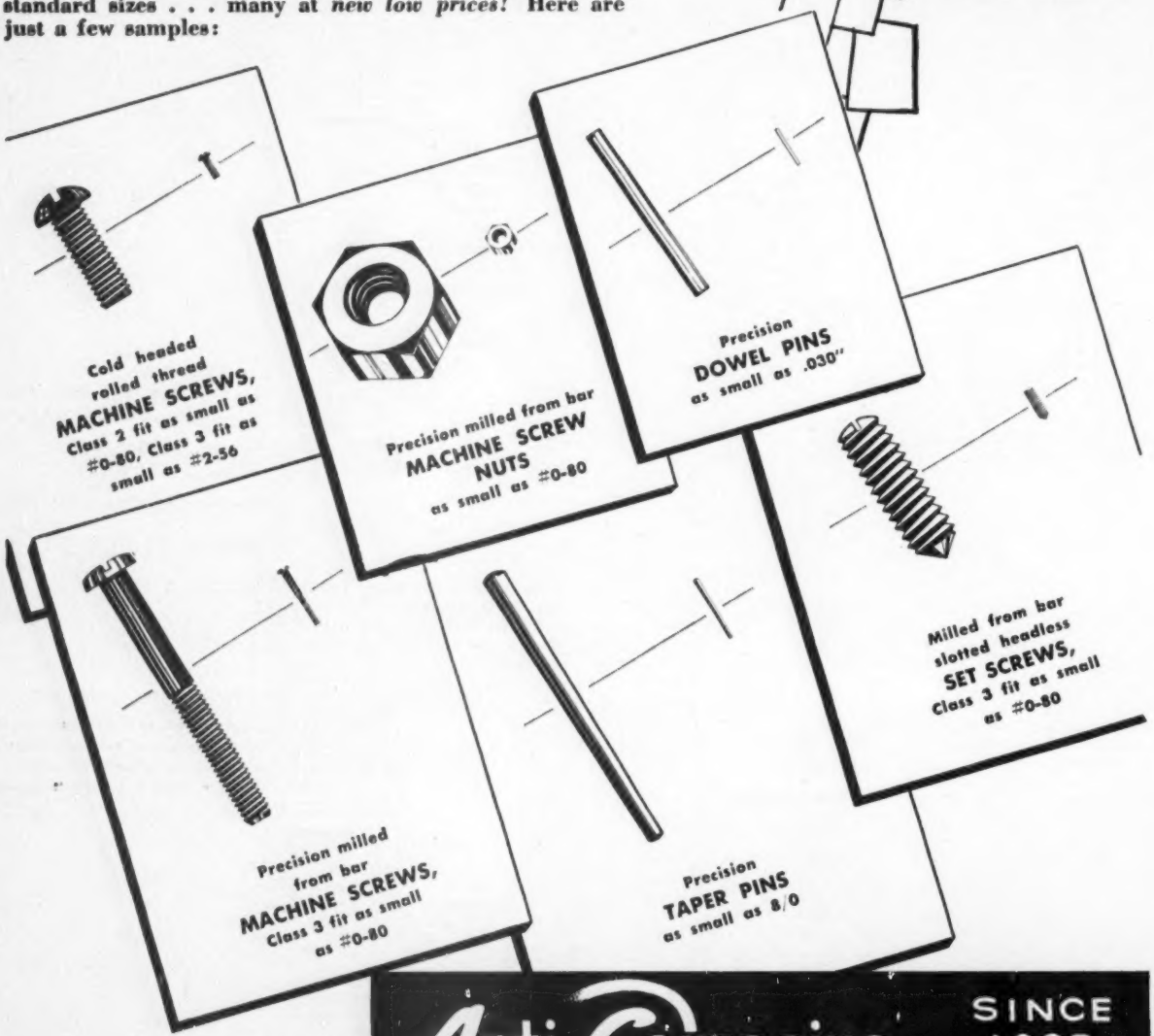
Cold headed rolled thread MACHINE SCREWS, Class 2 fit as small as #0-80, Class 3 fit as small as #2-56
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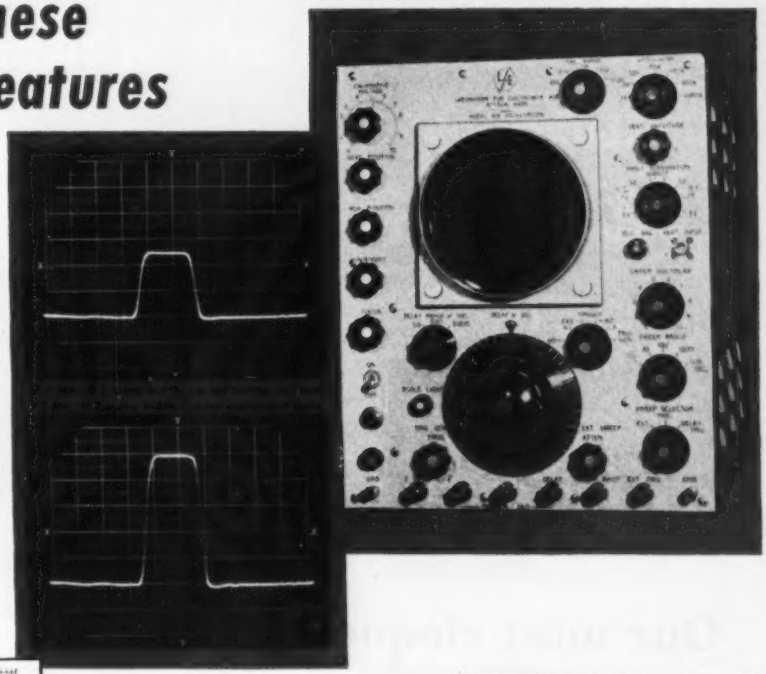
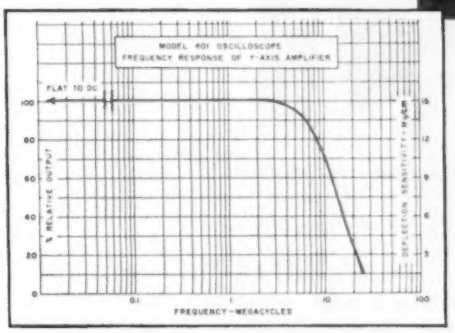


LINEARITY OF VERTICAL DEFLECTION The vertical amplifier provides up to 2.5 inches positive or negative uni-polar deflection without serious compression; at 3 inches, the compression is approximately 15%. The accompanying photographs illustrate transient response and linearity of deflection.



HIGH SENSITIVITY AND WIDE FREQUENCY RESPONSE OF Y-AXIS AMPLIFIER The vertical amplifier of the 401 has been designed to provide uniform response and high sensitivity *from D-C*. The accompanying amplifier response curve shows the output down 3 db. at 10 Mc. and 12 db. at 20 Mc. Alignment of the amplifier is for best transient response, resulting in no overshoot for pulses of short duration and fast rise time. Coupled with this wide band characteristic is a high deflection sensitivity of 15 Mv./cm. peak to peak, D-C and A-C.

SWEEP DELAY The accurately calibrated delay of the 401 provides means for measuring pulse widths, time intervals between pulses, accurately calibrating sweeps and other useful applications wherein accurate time measurements are required.

The absolute value of delay is accurate to within 1% of the full scale calibration. The incremental accuracy is good to within 0.1% of full scale calibration.

SPECIFICATIONS

Y-Axis

Deflection Sens.—15 Mv./cm, peak-to-peak.

Frequency Response—DC to 10 Mc

Signal Delay—0.25 μsec

Input line terminations—52, 72 or 93 ohms, or no termination

Input Imp.—Direct—1 megohm, 30 $\mu\mu$f
Probe—10 megohms, 10 $\mu\mu$f

X-Axis

Sweep Range—0.01 sec/cm to 0.1 μsec/cm

Delay Sweep Range—5-5000 μsec in three adjustable ranges.

Triggers—Internal or External, + and −, trigger generator, or 60 cycles, or undelayed or delayed triggers may be used.

Built-in trigger generator with repetition rate from 500-5000 cps.

General

Low Capacity probe

Functionally colored control knobs

Folding stand for better viewing

Adjustable scale lighting

Facilities for mounting cameras

PRICE: $895.00

Additional Features:

TRIGGER GENERATOR with variable repetition rate from 500 to 5000 cps.

POSITIVE & NEGATIVE UNDELAYED TRIGGERS and a **POSITIVE DELAYED TRIGGER** are externally available.

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A **FOLDING STAND** for convenient viewing.

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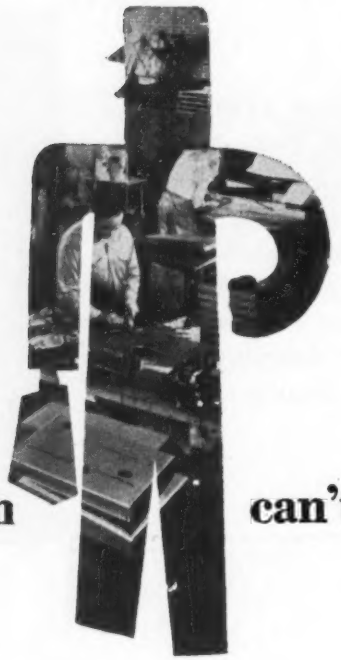

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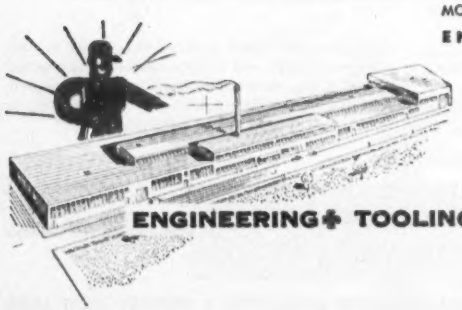

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3X2500A3	250TL
3X2500F3	304TH
3X3000A1	304TL
3X3000F1	450TH
6C21	450TL
75T	592/3-200A3
35T	750TL
35TG	1000T
75TH	1500T
75TL	2000T
100TH	

TETRODES

4-65A	4W20000A
4-125A	4X150A
4-250A	4X150D
4-400A	4X150G
4-1000A	4X500A
4PR60A	4X500F

PENTODE

4E27A/5-125B

RECTIFIERS

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2-25A	250R
2-50A	253
2-150D	866A
2-240A	872A
2-2000A	8020 (100R)
KY21A	

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4-400A/4006*
4-1000A/4000
4-1000A/4006*
4X150A/4000
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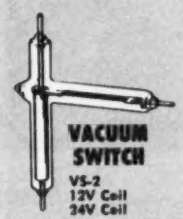

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HV-1
OIL
DIFFUSION
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Type A
Pump Oil
HV-1
Pump Parts

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VVC2-60-20
VVC4-60-20

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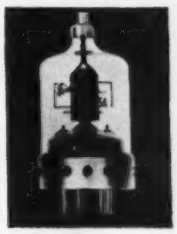
100 IG ion gauge

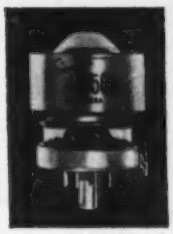
VACUUM CAPACITORS

VC6-20	VC25-20
VC6-32	VC25-32
VC12-20	VC50-20
VC12-32	VC50-32



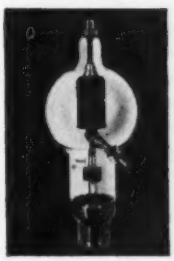
4-125A

The radial-beam power tetrode that made transmitting screen-grid tubes popular. This tube will take a plate input of 500 watts for CW or 380 watts for fone. Driving power is less than two watts. A pair of these tetrodes make an ideal high power fone or CW final for the amateur.



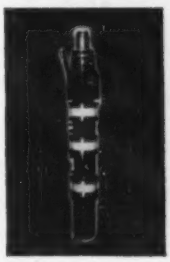
4X150A

This small external anode radial-beam power tetrode operates efficiently at all frequencies into the UHF range with a driving power of only a few watts. Its small size and ruggedness make it ideal for compact equipment such as mobile.



450T

Often referred to as the workhorse of modern communication systems, this dependable triode has a plate dissipation rating of 450 watts. It is widely used as an amplifier, oscillator or modulator.

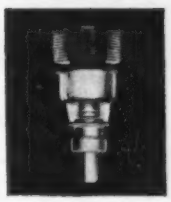


3K20000L (A-F-K)

These Klystrons, the latest development in UHF television transmitting, have a power output of 5000 watts. The three versions of the Klystron will cover the entire UHF range —470-890 mc. These water and air cooled Klystrons have a power gain of 20 db.

VVC60-20

This is but one type in the Eimac line of variable and fixed vacuum capacitors for plate tank circuits. It is variable over a range of 10 mmfd to 60 mmfd. Maximum rf voltage is 20 kv. at 40 amperes.



2C39A

This small, rugged triode is designed for use as a power amplifier, oscillator or frequency multiplier to frequencies above 2500 mc. It is particularly suitable for compact fixed or mobile equipment.

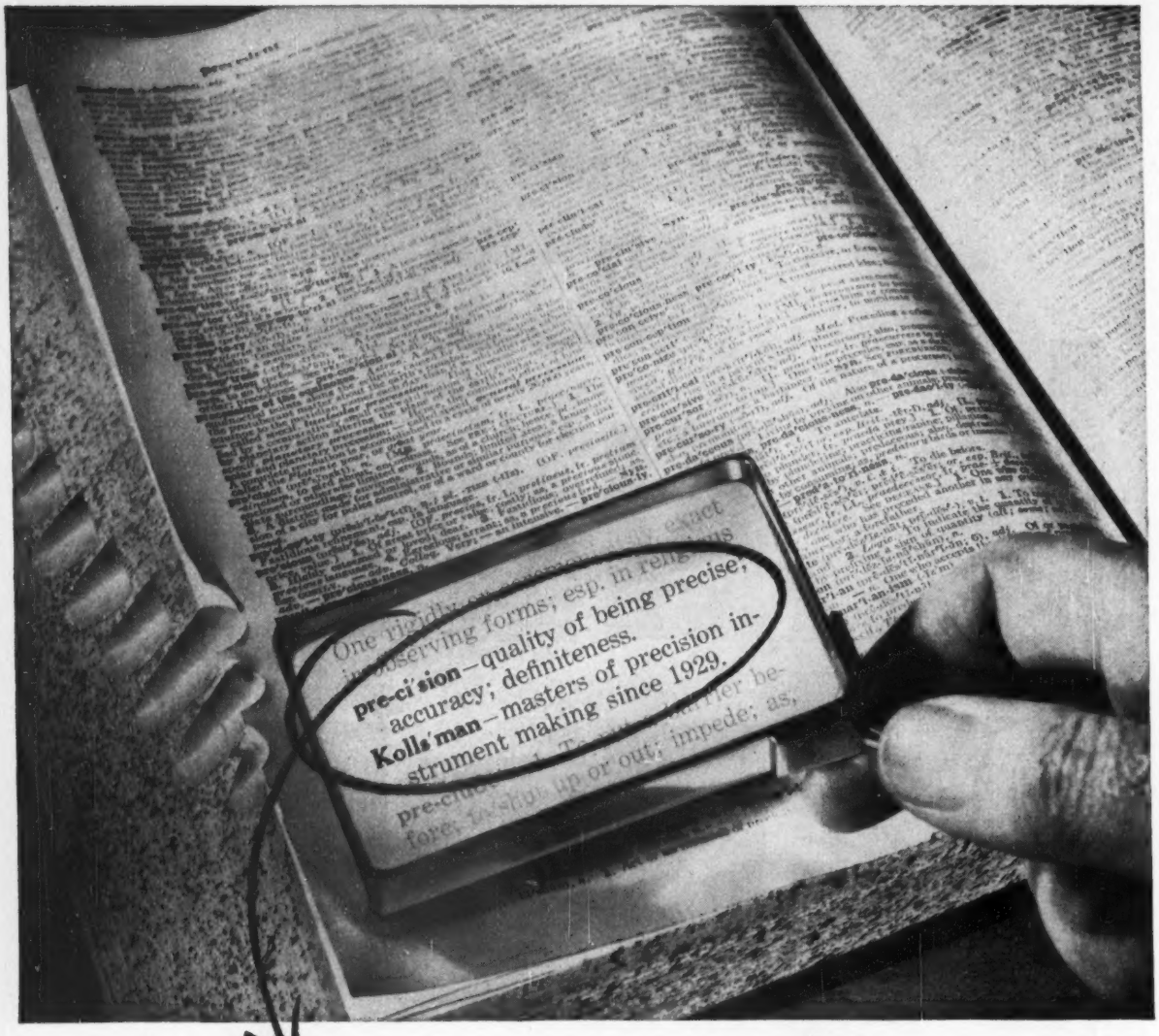
Eimac TUBES

- Complete technical data available on request.

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

EXPORT AGENTS: FRAZAR & HANSEN • 301 CLAY STREET • SAN FRANCISCO 11, CALIFORNIA


pre-ci'sion—quality of being precise; accuracy; definiteness.
Kolls'man—masters of precision instrument making since 1929.

Synonyms

THE KOLLSMAN INSTRUMENT CORPORATION—designers, developers and manufacturers of precise, dependable instruments in the fields of:

Aircraft Instruments and Controls • • Miniature AC Motors for Indicating and Remote Control Applications • • Optical Parts and Optical Devices • • Radio Communications and Navigation Equipment

While current facilities of our laboratories and plants are geared to production for National Defense, the planning divisions of Kollsman are ever active. And versatile Kollsman research engineers stand ready to assist America's scientists in the solution of instrumentation and control problems.

KOLLSMAN INSTRUMENT CORPORATION
ELMHURST, NEW YORK GLENDALE, CALIFORNIA
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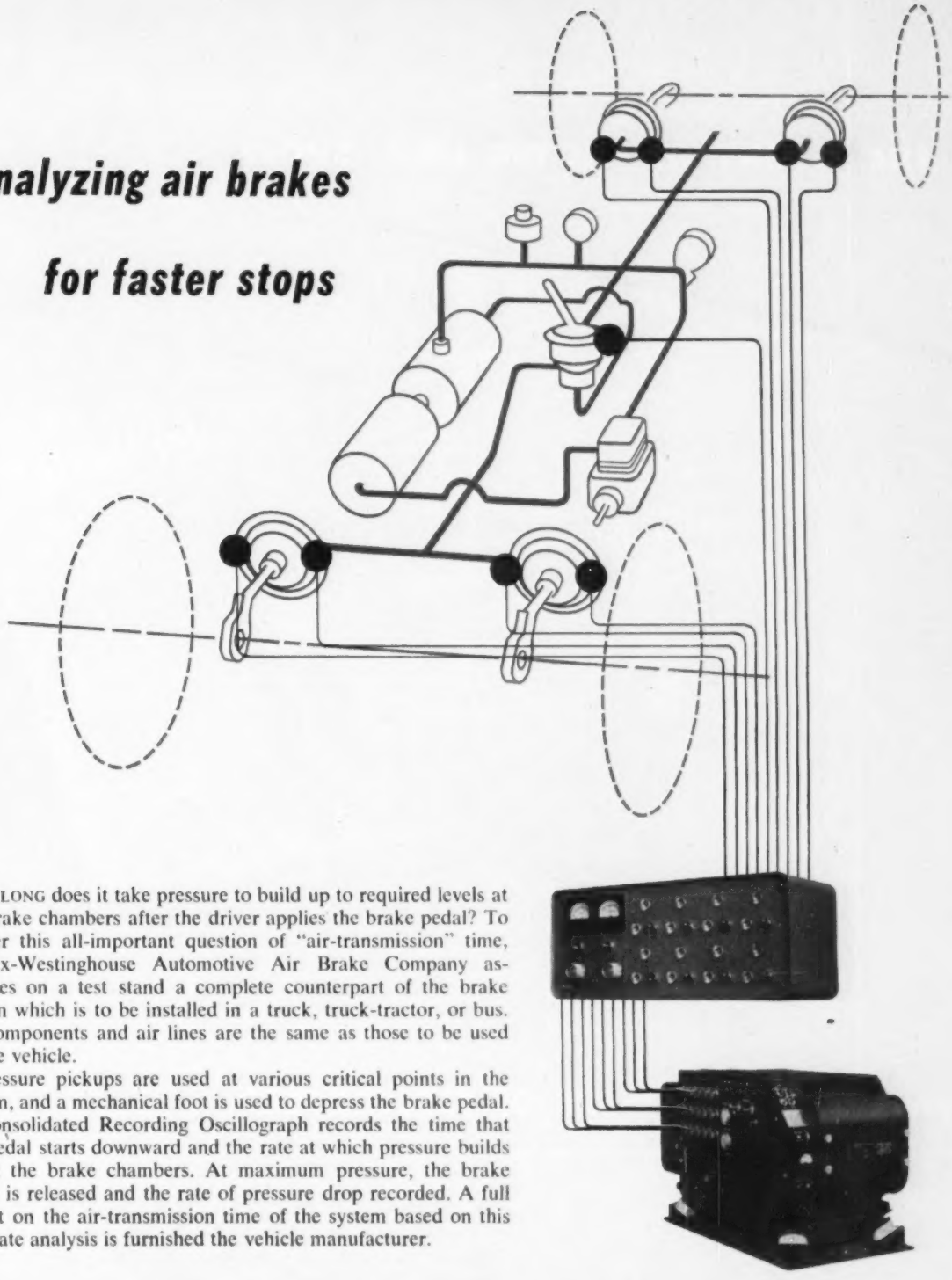
Standard COIL PRODUCTS CO. INC.

Analyzing air brakes for faster stops



HOW LONG does it take pressure to build up to required levels at the brake chambers after the driver applies the brake pedal? To answer this all-important question of "air-transmission" time, Bendix-Westinghouse Automotive Air Brake Company assembles on a test stand a complete counterpart of the brake system which is to be installed in a truck, truck-tractor, or bus. All components and air lines are the same as those to be used on the vehicle.

Pressure pickups are used at various critical points in the system, and a mechanical foot is used to depress the brake pedal. A Consolidated Recording Oscillograph records the time that the pedal starts downward and the rate at which pressure builds up at the brake chambers. At maximum pressure, the brake pedal is released and the rate of pressure drop recorded. A full report on the air-transmission time of the system based on this accurate analysis is furnished the vehicle manufacturer.

Consolidated Engineering CORPORATION

300 North Sierra Madre Villa, Pasadena 8, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington D. C., Philadelphia, Dayton.*

analytical instruments for science and industry

Dynamic Recording Systems

. . . like the one shown here are designed and manufactured by Consolidated. Variations in the arrangement of the equipment are infinite. Applications are widely varied throughout industry and the sciences. A typical recording system includes pickups, amplifiers or bridge balances, and a recording oscillograph. Write for Bulletin CEC 1500B.

THE STORY OF THE BIG I.R.E. SHOW

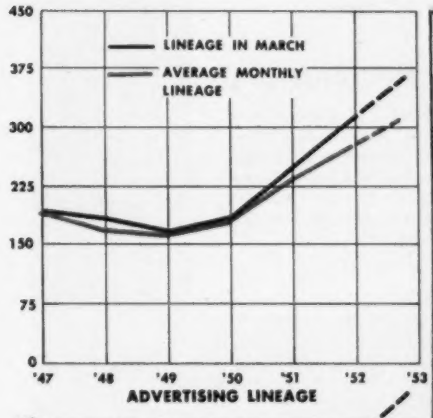
and THE BIG ISSUE OF ELECTRONICS

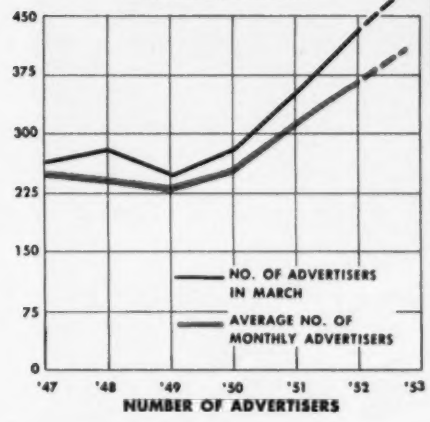
The March I.R.E. Show has become the accepted focal point of interest for everyone concerned with any aspect of electronics — engineering or sales. It is the highlight of the year that brings out in the open the equipment, components and materials of tomorrow and, as such, has always attracted one of the largest audiences of any technical show. The March issue of ELECTRONICS has, through the years, been the preferred medium through which manufacturers have apprised individual customers and prospects of their participation in this show or as a "Show in Print" if they are not exhibiting. Proof of that is shown on the next page.

HERE'S SIX YEARS PROOF OF...

Voluntary Acceptance

In the last six years, during which time the I.R.E. Show has achieved wide international prominence, the March issue of ELECTRONICS has enjoyed a considerable increase in advertising space over the average monthly space for all of those years. And, this, despite the fact that the March issue has never been promoted in any fashion as a special issue. This increase is entirely due to voluntary acceptance. Manufacturers, whether exhibitors or not, just naturally turn to ELECTRONICS as the most effective means of alerting the widest audience of customers and prospects. Proof can be found in the charts below – the facts are given in clear detail for the years from 1947 through 1952.





YEAR	ADVERTISING LINEAGE IN MARCH (pages)	AVERAGE MONTHLY ADVERTISING LINEAGE FOR YEAR	NUMBER OF ADVERTISERS IN MARCH	AVERAGE NUMBER OF ADVERTISERS MONTHLY
1947	195.33	189.95	264	248.83
1948	187.33	168.32	281	240.42
1949	172.17	156.81	250	225.83
1950	190.50	174.53	284	249.00
1951	255.83	226.57	354	308.00
1952	317.83	268.92	437	360.50

MAKE PLANS AND SPACE RESERVATIONS NOW

The 1953 I.R.E. Show promises to be better than ever before. All manufacturers participating should make plans and space reservations in the March issue of ELECTRONICS now. It is the best insurance you can get of wide attendance and interest in your booth. If you are not exhibiting, this carefully read issue can serve as your "Show in Print." For rates or further details, consult your nearest ELECTRONICS district manager or write direct to ELECTRONICS.

MANUFACTURERS HAVE ALWAYS SAID...

"See you at the show"

IN

electronics

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ABC

keeping communications ON THE BEAM

JK PRODUCTS

JK STABILIZED H-4 CRYSTAL

CRYSTALS FOR THE CRITICAL

A versatile crystal the JK H-4 is widely used as a replacement crystal in marine and other communications systems. Pressure mounted, dust and water proof, stainless steel electrodes. Frequency range 1800 kc to 15 mc. Military type holder. Another of the many JK Crystals available to serve every need.

Ship-to-Shore is Ship Shape

His decks may be awash but there's fair weather in the radio shack. Despite wind and waves the Captain's message will reach the home port. In fair weather or foul, you'll find JK Crystals rate a Navy "E" for their part in keeping marine communications "ship shape."

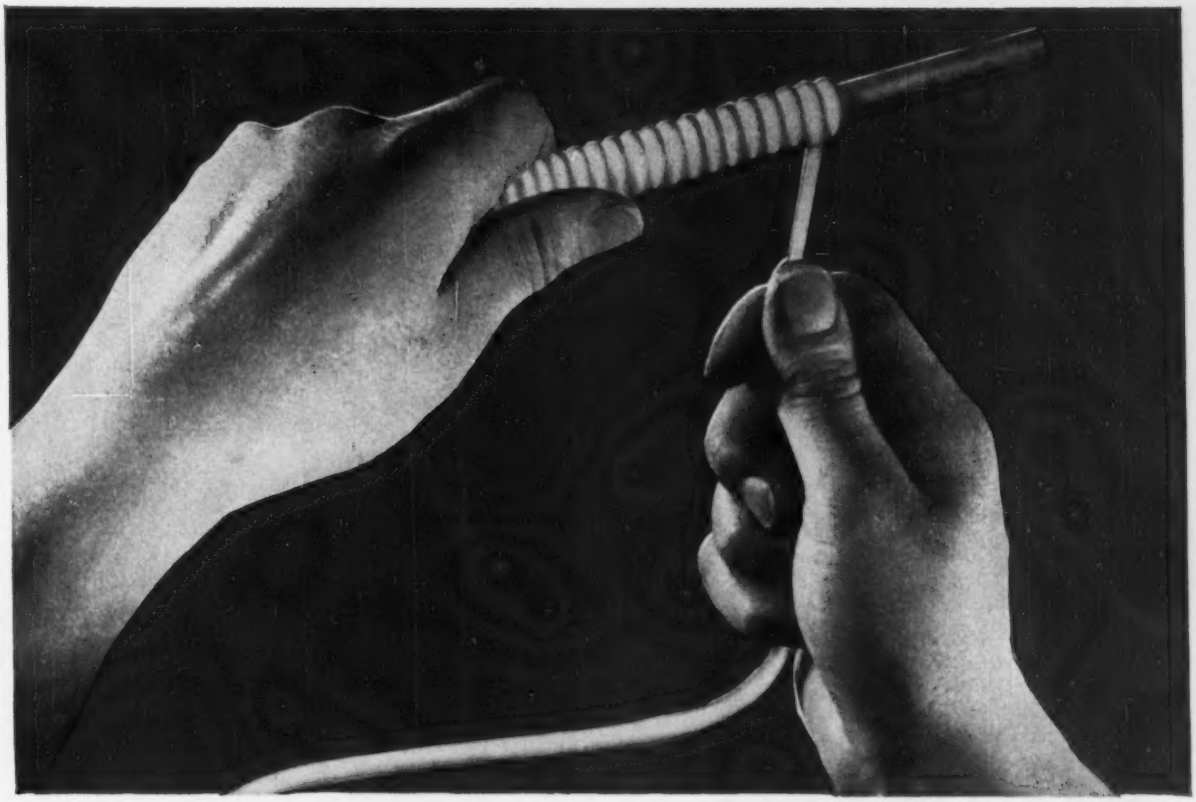
the JK FR-12

FREQUENCY & MODULATION MONITOR

Monitors any four frequencies anywhere between 25 mc and 175 mc, checking both frequency deviation and amount of modulation. Keeps the "beam" on allocation; guarantees more solid coverage, too!

THE JAMES KNIGHTS COMPANY

SANDWICH ILLINOIS



Now . . . an extremely flexible high-temperature tubing . . . IRVINGTON Silicone Rubber-Coated Fiberglas*

If you need a *flexible* insulating tubing that meets Class "H" specifications—and particularly if you need it *now*—look into this new Irvington product!

With the introduction of Silicone *Rubber*-Coated Fiberglas Tubing, Irvington offers to the electrical industry a product that, like the resin-coated type, meets all NEMA Class "H" requirements. In addition, this new tubing has the advantage of extreme flexibility. Its white color is a plus wherever appearance is a factor.

AND . . . Irvington Silicone Rubber-Coated Fiberglas Tubing is available for immediate delivery!

Get the full story—just mail the coupon for technical data sheet.

*T.M. Reg. U. S. Pat. Off. by Owens-Corning Fiberglas Corp.

Send this convenient coupon now

Irvington

VARNISH & INSULATOR COMPANY

Irvington 11, New Jersey

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

Irvington Varnish & Insulator Co. EL-2-53
11 Argyle Terrace, Irvington 11, N. J.

Gentlemen:
Please send me technical data sheet on Irvington Silicone Rubber-Coated Fiberglas Insulating Tubing.

Name.....Title.....

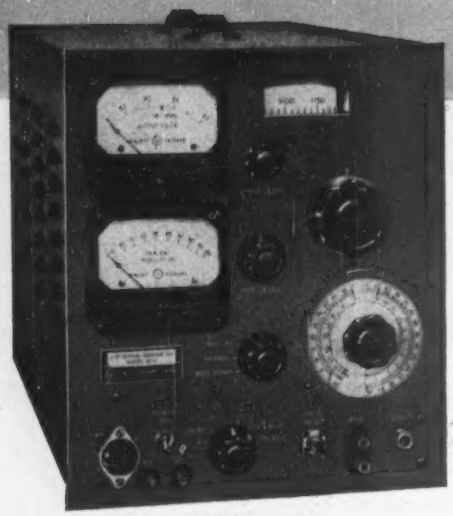
Company.....

Street.....

City.....Zone.....State.....

ELECTRONIC TEST

New *Multi-purpose*



New!

-hp- 612A — VERSATILE, DIRECT READING. FOR UHF-TV, OTHER WORK 450 TO 1,200 mc

This master oscillator-power amplifier generator is especially designed for UHF-TV measurements including receiver and amplifier gain, selectivity, sensitivity and image rejection. It is also a convenient, direct-reading laboratory power source for driving bridges, slotted lines, antennas and filter networks. Both frequency and output are directly set on large, precisely calibrated dials. No charts or interpolation are required.

Model 612A has a maximum output of 0.5 volts into 50 ohms over its entire frequency range. The instrument also has low incidental fm and broad band modulation up to 5 mc. It may be modulated internally or externally, amplitude modulated, or pulse modulated (good rf pulses 0.2 μsec or longer). Pulse modulation may be applied to the amplifier; or direct to the oscillator when high on-off signal ratios are required.

BRIEF SPECIFICATIONS

Frequency Range: 450 to 1,200 mc, 1 band.

Accuracy: Calibration ±1%. Resettability better than 5 mc at high frequencies.

Output: 0.1 μv to 0.5 v continuously variable. Calibrated in volts and dbm. Impedance 50 ohms. Max. VSWR 1.2. Accuracy ±1 db entire range.

Modulation: Amplitude: From 0 to 90% indicated by panel meter.

Envelope Distortion: 2% at 30% modulation.

Internal: Fixed modulation frequencies, 400 and 1,000 cps.

External: Any frequency 20 cps to 5 mc.

Pulse Requirements, External Modulation:

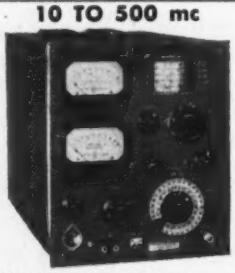
Pulse to Amplifier: Good pulse shape at 0.2 μsec length.

Pulse to Oscillator: 1.0 μsec minimum.

Size: Cabinet 12" x 14" x 18" deep.

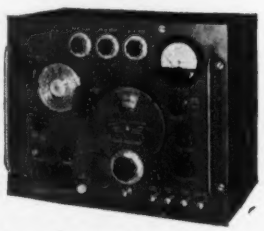
Price: $1,200.00

10 TO 500 mc



-hp- 608A VHF Signal Generator provides output ranging from 0.1 μv to 1.0 v into 50 ohms. Accuracy is ±1 db. Direct reading frequency and output calibration; no charts or interpolation required. Pulsed, cw or amplitude modulated output (50 cps to 1 mc). Resettability better than 1 mc. Has master oscillator-power amplifier for widest modulation capabilities. Constant internal impedance. Maximum VSWR 1.2. $850.00

800 TO 2,100 mc

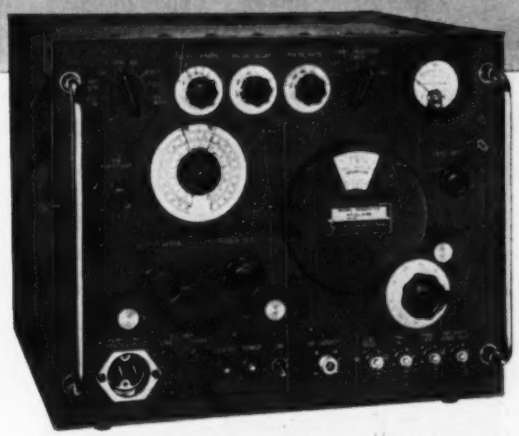


-hp- 614A UHF Signal Generator provides output ranging from 0.1 μv to 0.223 v (1 mw) into 50 ohms. Accuracy ±1 db. Has single dial, direct reading frequency and output, no charts or interpolation. Offers cw, fm or pulsed output. Widely variable pulsing, synchronizing, delay and triggering features. Extremely fast rise/decay time of 0.1 μsec. Constant internal impedance. Maximum VSWR 1.6. $1,950.00

HEWLETT-PACKARD

INSTRUMENTS

SIGNAL GENERATORS



New!

-hp- 618B — VARIED PULSING CAPABILITIES, DIRECT READING. RANGE 3,800 TO 7,600 mc

Model 618B offers faster, more accurate measurement of component performance in radar, radio relay and TV carrier systems and similar field and laboratory applications. Frequency is generated in a reflex klystron oscillator; accuracy and stability are high throughout the instrument's wide frequency range. Frequency and voltage are directly set and read. Dial tuning is tracked automatically, and no voltage adjustment is required during operation.

Extremely wide pulsing capabilities have been built into *-hp-* 618B. The instrument may be internally or externally pulse modulated, internally square wave modulated and frequency modulated. The repetition rate is continuously variable between 40 and 4,000 pps. Pulse width is variable 0.5 to 10 μsec. Sync-out signals are simultaneous with the rf pulse or in advance by any time-span from 3 to 300 μsec. The instrument also may be synchronized with an external sine wave, or with positive or negative pulse signals.

BRIEF SPECIFICATIONS

Frequency Range: 3,800 to 7,600 mc. 1 band.

Calibration: Direct. Accuracy better than 1%.

Stability: Frequency: less than 0.006% per °C change.
Line Variation: ±10 v causes less than 0.01% frequency change.

Output: 1 mw/0.223 v to 0.1 μv into 52 ohms. (0 to –127 dbm).

Modulation: Internal or external pulse, fm, or internal square wave.

External Sync: (1) Sine wave 40 to 4,000 cps, 5 to 50 v rms.
(2) Pulse signals 40 to 4,000 pps, 5 to 50 v (pos. and neg.). Pulse width 0.5 to 5 μsec. Rise time 0.1 to 1.0 μsec.

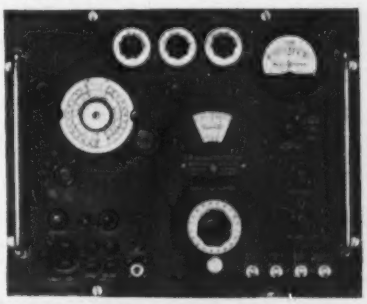
Size: Cabinet 16¾" x 13½" x 16" deep.

Price: $2,250.00

Data subject to change without notice. Prices f.o.b. factory.

1,800 TO 4,000 mc

-hp- 616A UHF Signal Generator offers the same simple operation, wide pulsing capabilities, high stability and accuracy as *-hp-* 618B, but is designed for UHF frequencies. Output ranges from 0.1 μv to 0.223 v (1 mw) into a 50-ohm load. Accuracy is ±1 db. Output may be cw, fm or pulsed. Modulation and synchronizing features are similar with *-hp-* 618B. Oscillator section is a reflex klystron. Frequency changes are automatically tracked and no voltage adjustment is needed during operation. Frequency and output are directly set and read on large, carefully calibrated dials. No charts or interpolation are needed. $1,950.00



For complete details, see your -hp- field representative or write direct

HEWLETT-PACKARD COMPANY

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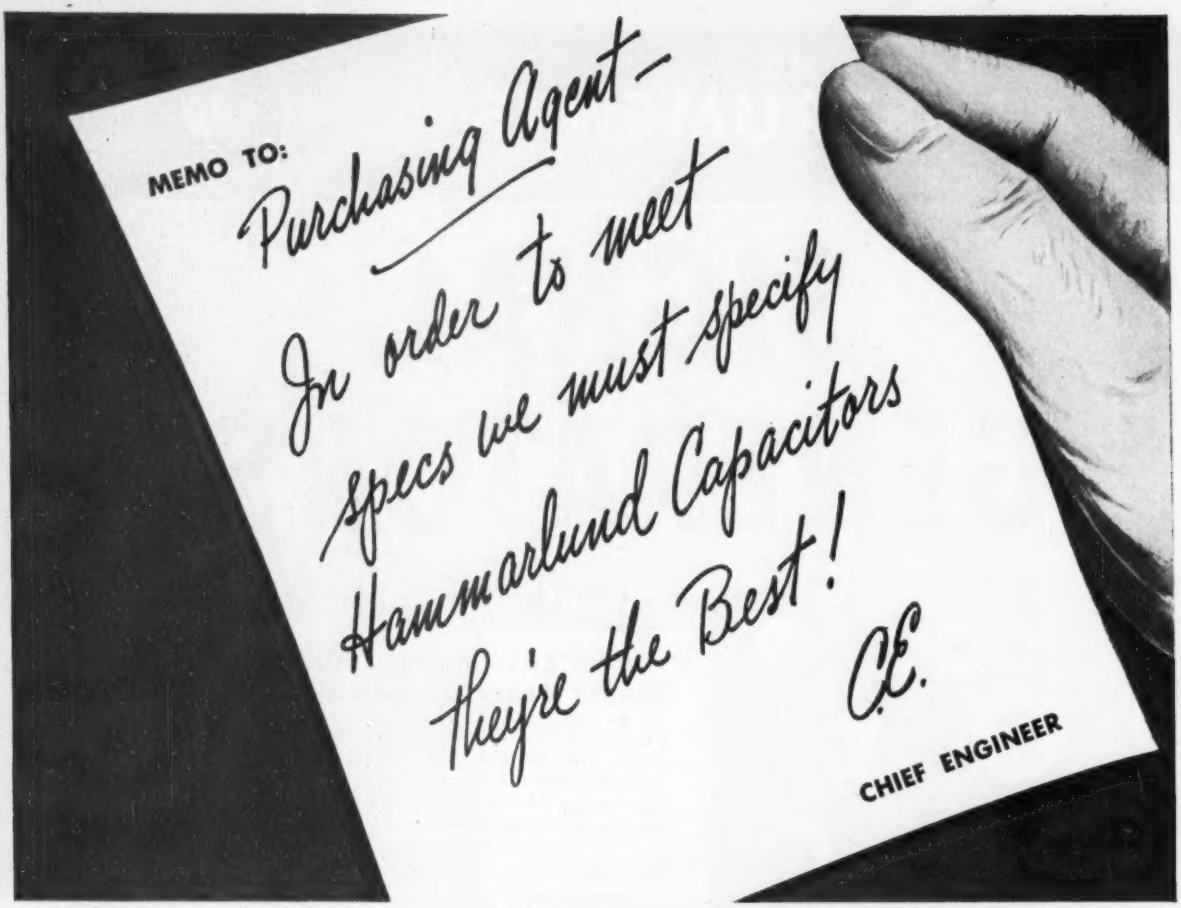
INSTRUMENTS

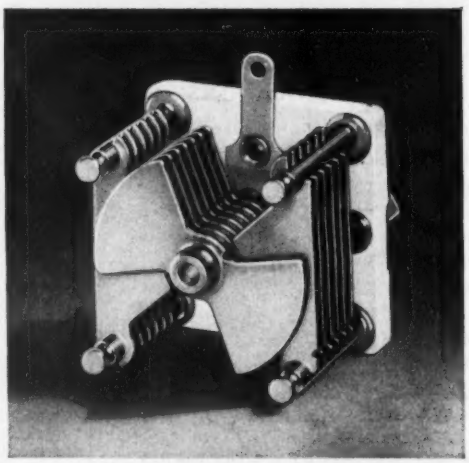


They've always been the best!

VARIABLE CAPACITORS

Hammarlund Capacitors, backed by 42 years of design, engineering and production experience, are today recognized by the military services, electronic manufacturers and research engineers, as the finest quality capacitors available. Millions of them are in use by almost every important manufacturer of electronic equipment.

See for yourself. Write today for the 1952 CAPACITOR CATALOG. It has the complete story.



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THE HAMMARLUND MANUFACTURING CO., INC.

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KOVAR* Glass Sealing Alloy

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15 YEARS

RAYTHEON
17 YEARS

17 YEARS

SPERRY
12 YEARS

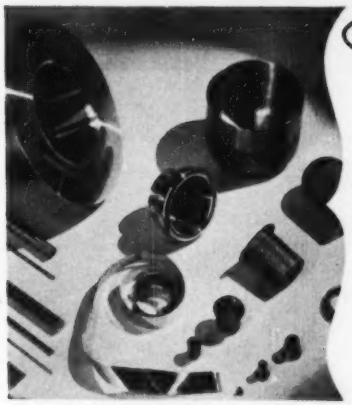
Eimac TUBES
12 YEARS

RCA
17 YEARS

VARIAN associates
4 YEARS

Bomac
5 YEARS

The Most DEPENDABLE Proved by Experience



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14 YEARS

WESTINGHOUSE
17 YEARS

6 YEARS

17 YEARS

FEDERAL TELEPHONE & RADIO FTR
10 YEARS

Supplied by Stupakoff

in the form of: SHEET, ROD, WIRE, FOIL, TUBING, EYELETS, LEADS and FABRICATED SHAPES

The ideal alloy for glass sealing, Kovar matches the expansivity of certain hard glasses over the entire working temperature range. It resists mercury attack, has ample mechanical strength and seals readily with simple oxidation procedure. It is available as sheet, strip, foil, rod, tube, wire—or fabricated into cups, eyelets, leads and other shapes. The prominent users of KOVAR and the length of time they have employed this metal are convincing proof of satisfaction.

*Westinghouse Trade Mark No. 337,962

STUPAKOFF *Products for Electrical and Electronic Applications*

ASSEMBLIES—Metallized ceramic induction coils and shafts; metallized plates for fixed rigid assemblies; ceramic trimmer condensers.

CERAMICS—Precision-made ceramic products for electrical and electronic applications, all voltages, frequencies and temperatures.

RESISTOR CERAMICS—Used for temperature indicating or measuring equipment, for infra-red light source and for heating elements. Complete with terminals, in the form of rods, tubes, discs, bars, rings, etc.

CERAMIC DIELECTRICS—For by-pass, lead-through, blocking, stand-off and trimmer applications. Temperature compensating Ceramic Dielectrics and high K materials. Tubes, discs and special shapes, plain or silvered.

PRINTED CIRCUITS—Amplifiers, couplings, filters, integrators.

STUPALITH—Will withstand extreme thermal shock. May be made to have zero, low-positive or negative expansivities. Safely used at temperatures up to 2400° F.

SEALS, KOVAR-GLASS—Terminals, Lead-ins, Stand-offs—for hermetically sealing and mechanical construction in radio, television, electronic and electrical apparatus. Single or multiple terminal units, in a wide variety of sizes and ratings.

KOVAR METAL—The ideal alloy for sealing to hard glass. Used for making hermetic attachments. Available as rod, wire, sheet, foil—or as cups, eyelets and other shapes.

STUPAKOFF CERAMIC & MFG. CO., Latrobe, Pennsylvania

Precision-Built . . . *for dependable performance*

Whatever your requirements for top quality wire-wound components, you can count on I-T-E products. Power resistors, precision resistors, deflection yokes—all are specially designed and precision-built to meet the exacting standards demanded for critical electronic applications. Close quality control and modern production methods give you assurance of *quality* components in any quantity you need.

I-T-E POWER RESISTORS

Non-hygroscopic ceramic foundations are in accordance with JAN specifications.

Purest resistance wires are uniformly wound to prevent shorted turns and excessive hot spots. All connections silver-soldered.

Vitreous enamel coating (organic if required) provides a glazed moisture-repellent surface with fast heat-dissipation qualities.

Advanced production methods assure high stability, long life.

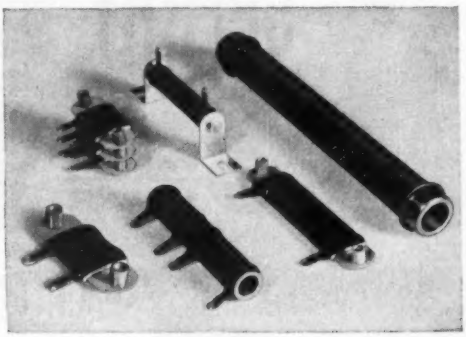
Standard fixed resistors:
5-200 watts

Adjustable resistors:
10-200 watts

Oval resistors:
30-75 watts

Ferrule resistors:
12-200 watts

Special resistors:
built to specifications



Standard Tolerance: ±10%. ±5% *and less* made to order.

I-T-E PRECISION RESISTORS

High-quality wire alloys are used—free from internal stresses and strains.

Automatic precision winding assures even tension—eliminates hot spots.

Hermetic or vacuum-impregnated sealing protects against destructive effects of salts, moisture, and atmospheric conditions.

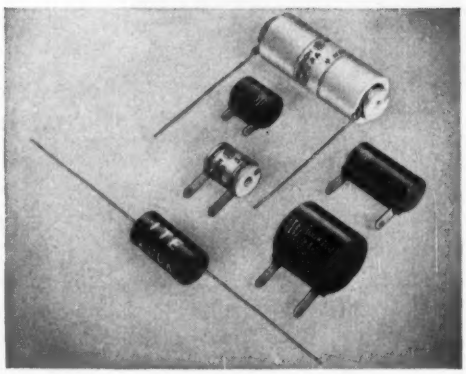
Accelerated aging process prior to calibration assures accuracy.

Critical quality control eliminates all resistors which do not come up to high I-T-E standards.

TYPE A:
lightweight, hermetically sealed—for precision operation up to 125° C. Surpass JAN R-93 A, *Characteristic A*, and MIL R-93 A specifications.

TYPE B:
vacuum-impregnated, moisture-resistant. For JAN R-93, *Characteristic B*, specifications.

Ratings from 0.01 ohm-10 megohms, 0.125-5 watts.



Standard Tolerance:
±1%. Available in specified tolerances down to ±0.05%.

I-T-E DEFLECTION YOKES

Wire size and quality constantly checked. Coils impregnated in special moisture-resistant thermoplastic—properly cured to assure firm coil with minimum losses. Yokes can be obtained complete with wire leads, resistors, and capacitors to your specifications.

WRITE FOR DETAILS

I-T-E

WIRE-WOUND PRODUCTS

I-T-E RESISTOR DIVISION

1924 Hamilton St., Phila. 30, Pa. • A division of the I-T-E Circuit Breaker Co.

Prove to yourself...

These are better AN connectors--and at competitive prices

BETTER...

...Because Monowatt *AN* Connectors have *all* these features:

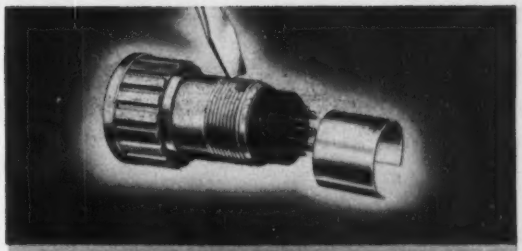
- ***Moisture-proof seal.*** **Two-piece inserts are joined with a silicone sealing compound. Moisture and condensation effectively excluded... parts held together while inserts are soldered to cable assemblies.**
- ***Diallyl Phthalate insert material*** **(blue) used in all connectors. Negligible post-mold shrinkage... superior dielectric properties.**
- ***Fewer parts and simpler design*** **make installation and inspection easy.**
- ***Cadmium-plated housings*** **resist corrosion.**
- ***Tellurium copper pins,*** **heavily silver-plated, insure greater conductivity... 99% that of copper.**
- ***Available in complete wiring harness or cable assemblies.*** **Made by Monowatt to your specifications.**

PRICED RIGHT...

...Because the Monowatt Department of General Electric has complete modern facilities for mass-production, these features are offered at competitive prices.

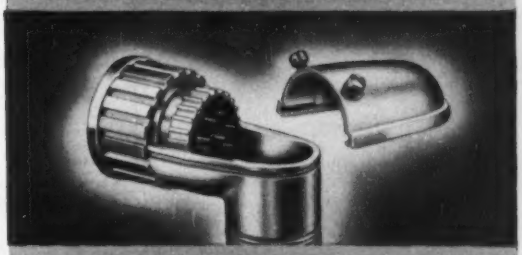
THE PROOF STARTS WITH THE QUOTATION

...*Prove to yourself* that Monowatt *AN* Connectors at competitive prices bring you extras—extras which save assembly time and insure a superior connecting job.



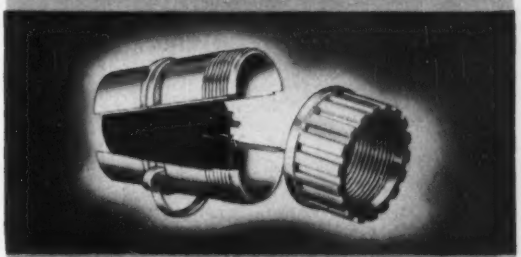
AN Solid Shell Connector

BETTER... because its snap-in retaining sleeve cannot work loose, yet can be released quickly with a screw driver and the insert removed for inspection or soldering.



AN Split-Shell 90° Angle Plug

BETTER... because top can be removed to inspect wiring without unmating or disassembling plug from conduit or cable. Conduit thread is not split. Split-shell ease of wiring is combined with advantages of solid shell construction.



AN Split-Shell Straight Plug

BETTER... because Monowatt engineers have succeeded in reducing number of metal parts and weight, while improving connector performance. This type is preferred where assembly must be made in tight places.

Send your specifications with this coupon. In return you'll receive a catalog describing the unique cost-saving features of Monowatt electrical connectors and wiring assemblies for aircraft, ordnance and electronic equipment — plus — quotations on your specific requirements. If you wish, a representative will call with sample connectors... all without cost or obligation.

MAIL COUPON AND YOUR SPECIFICATIONS TODAY.

MONOWATT

Monowatt Department G11, General Electric Company
95 Hathaway St., Providence 7, R. I.

☐ Please quote on the attached specifications and send catalog.
☐ Please quote on the attached specifications and have your representative call with sample connectors.
☐ Please send catalog only.

I understand neither the quotation, catalog nor call obligates me in any way.

Name .....
Title .....
Firm .....
Street ..... Zone ..... State .....
City .....

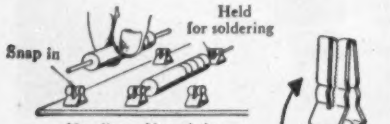
A DEPARTMENT OF GENERAL ELECTRIC COMPANY, PROVIDENCE 7, R. I.

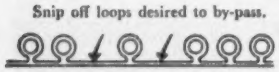
Here is Plug-in Unit Construction

Everything you need to mount, house, fasten, connect, monitor your equipment.

ALDEN MINIATURE TERMINALS

Here's a beautiful new little Terminal that really puts soldering on a production basis; taking a minimum of space and material. Ratchet holds leads firmly for soldering, no wrap-around or pliering necessary. Unique punch press configuration gives rapid heat transfer, taking less time and solder. Designed for Govt. Miniaturization contracts. Staked in Alden Prepunched Terminal Cards, allow patterns for any circuit.





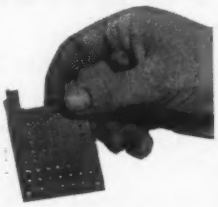
JUMPER STRIP

Stake under Terminals for common circuits. Loops match prepunched holes in Terminal Cards. Snip off loops desired to by-pass.

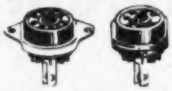
FOR YOUR SMALLER UNITS

1st Take Pre-punched Terminal Mounting Card ready-cut to size you require. Stake in Alden Miniature Terminals to mount your circuitry.

Prepunched Terminal Mounting Cards come in all sizes needed for Packages: miniature 7-pin and 9-pin units, or 11-pin and 20-pin plug-in units. Card is natural phenolic 1/16" thick prepunched on 1/4" centers with .101" holes for taking the Miniature Terminals.



2nd Attach Alden Card-mounting Tube Sockets and Mounting Brackets, which mount in the prepunched holes.



Alden Card-mounting Tube Sockets for miniature 7, miniature 9 and octal tubes, are complete with studs and eyelets for easy mounting on Prepunched Cards.

Mounting Brackets stake to the Prepunched Card, mount Card to Package Base and Lid.

FOR YOUR LARGER UNITS

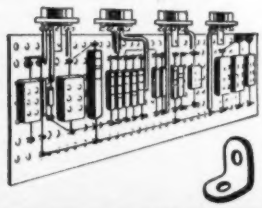
1st Lay out circuitry with Prepunched Terminal Mounting Card in lengths up to 3'.

READY MADE to fit various ready made Chassis sizes.

Organize circuitry in compact vertical planes. Use both sides of Prepunched Card to stake in Alden Miniature Terminals to your circuitry layout. Vertical position gives ready accessibility; there is no "underneath" in Alden design.

2nd Attach Alden Card-mounting Tube Sockets and Mounting Brackets, which fit any of the prepunched holes.

Alden Card-mounting Tube Sockets, ready-made in variety of sizes, complete with studs and eyelets for easy mounting on Prepunched Cards.



TO OBTAIN COMPLETE DETAILS

Tiny Sensing Elements specifically designed to spot trouble instantly in any unit.

Here are tiny components to isolate trouble instantly by providing visual tell-tales for each unit.

"PAN-i-LITE" MIN. INDICATOR LIGHT

So compact you can use it in places never before possible. Glows like a red-hot poker. Push-mounts in .348" drill hole. Bulbs replace from front. Tiny spares are unbreakable, easily kept available, taped in recess of equipment. Alden #86L, ruby, sapphire, pearl, emerald.

MINIATURE TEST POINT JACK

Here are tiny insulated Test Point Jacks that make possible checking critical plate or circuit voltages from the front of your equipment panel—without pulling out equipment or digging into the chassis. Takes a minimum of space, has low capacitance to ground, long life beryllium copper contacts. Available in black, red, blue, green, tan and brown phenolic conforming to MIL-P 14B- CGF; also nylon in black, red, orange, blue, yellow, white, green. Alden #110BCS.

ALDEN "FUSE-LITE"

Fuse Blows — Lite Glows.

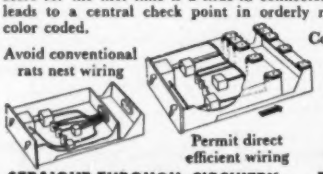
Signals immediately blown fuse. Lite visible from any angle. To replace fuse simply unscrew the 1-pc. Lite-lens unit. Mounts easily by standard production techniques, in absolute minimum of space. 110V Alden #440-4FH. 28V #440-6FH.

Free Samples Sent Upon Request

Get one point of check of all incoming and outgoing leads thru ALDEN BACK CONNECTORS

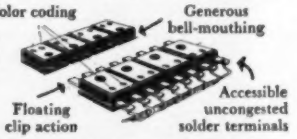
SINGLE CHECK POINT

Here for the first time is a slide-in connector that brings all incoming and outgoing leads to a central check point in orderly rows, every lead equally accessible and color coded.



STRAIGHT-THROUGH CIRCUITRY

Wiring is kept in orderly planes, avoiding rat's nest of conventional back plate wiring. Connections between Terminal Mounting Cards are through Back Connectors so that all circuitry is controlled at this central point. Incompatible voltages safely isolated and separated.



EASY INSERTION AND REMOVAL

Mating tolerances permit easy insertion and removal without demanding critical alignment tolerances. Assure proper contact, with safety shielding of dangerous voltages. Leads can be attached above, below or out of the back for most direct and efficient interconnects.

Ready-made Alden Back Connectors meet all conceivable needs, for slide-in chassis replaceable in 30 seconds with spare.

VISIT OUR COMPLETE DISPLAY AT THE I.R.E. SHOW

NA-ALD ALDEN PRODUCTS COMPANY

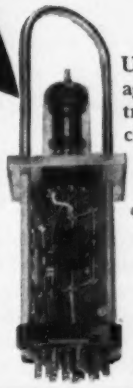
READY-MADE for your Electronic Equipment

All designed — all tooled — production immediately available — no procurement problems. ***Apply ALDEN Standards wholly or in part.***

ALDEN PLUG-IN PACKAGES

3rd After mounting your circuits on Terminal Cards, use Alden Standard Plug-in Bases, Housings, Bails for packaging.

Min. 7 & 9-pin BASES available, also 11-pin & 20-pin. BAILS & HOUSINGS or LIDS to match.



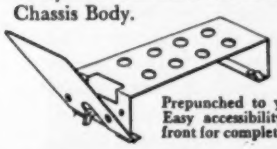
ALDEN PLUG-IN PACKAGES

Using standard Alden Plug-in Packaging Components you can mount a tremendous variety of circuits on chassis or in racks.

Alden "20" Rack Mounting Socket with extended ears that mount side by side and in multiple rows on U-Channels that accommodate 50 Alden "20" Plug-in Units illustrated, in 10½ x 19" rack mounting panel.

ALDEN BASIC CHASSIS

3rd Fit Prepunched Cards carrying completed circuitry into Standard Alden Basic Chassis Body.



Prepunched to your specs. Easy accessibility at sides, front for completing wiring.

SERV-A-UNIT LOCK
pulls in or ejects chassis.

SLIDE-IN BACK CONNECTORS

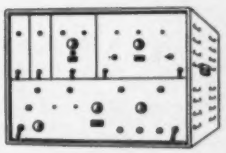
See description on opposite page.

ALDEN BASIC CHASSIS

with spares provides 30-second servicing for your unitized circuitry.

HOUSE PLUG-IN UNITS IN ALDEN BASIC UNI-RACKS

2" 4" 8" 17"



FOUR SIZES OF CHASSIS MOUNT IN ANY COMBINATION IN ALDEN UNI-RACKS

STACKED
Mounting all equipment in Alden Uni-Racks provides a uniform system easy to handle and ship. Can be installed and interconnected as fast as unloaded.

ALDEN UNIT CABLE

interconnects between Uni-racks or other major circuitry divisions. Quick, sure, coded means of isolating and restoring (with spare) inter-division circuits.

SEND FOR FREE "ALDEN HANDBOOK"

Your design and production men have always wanted these advantages:

1. Experimental circuitry can be set up with production components, cutting down debugging time.
2. Allows technicians, rather than engineer, to debug, by taking out unit.
3. Given the circuitry, nothing further to design—make up from standard Alden components.
4. Optimum circuit layout using standard terminal card.
5. Absolute minimum requirements of labor, materials, space.
6. The various sub-assemblies can be built concurrently on separate assembly lines.
7. No tooling costs—no delays—no procurement headaches.
8. Fewer prints—smaller parts inventory.
9. Can subcontract assemblies.

Your customers and sales force will welcome these advantages:

The big objection to electronic equipment—from the user's point of view—is that if it goes out of order he feels helpless. But you have a perfect answer when your equipment is made to Alden Standards of Plug-in Unit Construction because they assure DEPENDABLE OPERATION, as follows—

30-SECOND REPLACEMENT OF INOPERATIVE UNITS by plugging in available coded spares.

TROUBLE INSTANTLY INDICATED AND LOCATED by monitoring elements assigned to each functional unit.

TECHNICAL PERSONNEL NOT REQUIRED to maintain in operation, due to obvious color coding and fool-proof non-interchangeability of mating components.

TOOLESS MAINTENANCE made possible by patented Alden fasteners and plug-in locking and ejecting devices.

AIRMAIL SERVICE—
Compact functional units practical to send airmail to factory for needed overhaul.

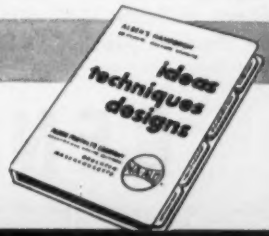
UNI-RACK FIELD HANDLING UNIT—groups functional units into stacking cabinets not exceeding one- or two-man handling capacity—go easily through windows, doors.

CONNECT AS FAST AS UNLOADED, by coded non-interchangeable unit cables plugged in between Uni-racks.

SEND FOR FREE 226-PAGE HANDBOOK

This 226-page Handbook describes fully the Alden System of Plug-in Unit Construction and the hundreds of components ready-made and completely tooled to meet your every requirement. It's a gold-mine for those designing electronic control equipment that is practical in manufacture; dependable in operation.

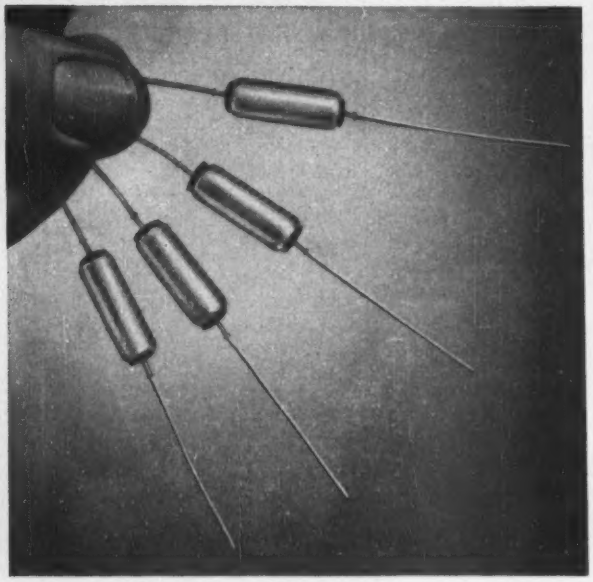
REQUEST YOUR COPY TODAY — SENT FREE!



127 North Main Street • Brockton 64 • Massachusetts

NA-ALD

DESIGNER'S



Miniaturize your product with Tantalytic* capacitors

On low-voltage d-c applications, where your equipment miniaturization calls for both small size and superior performance, General Electric Tantalytic capacitors offer a host of advantages. These foil-type, tantalum-electrode, electrolytic capacitors have greater capacitance per unit volume and far longer shelf life than aluminum-electrolytic types. Long operating life, too, is provided by their inherently inert characteristics, and the use of non-corrosive, chemically neutral electrolyte. And leakage current is low—less than 10 microamps per microfarad.

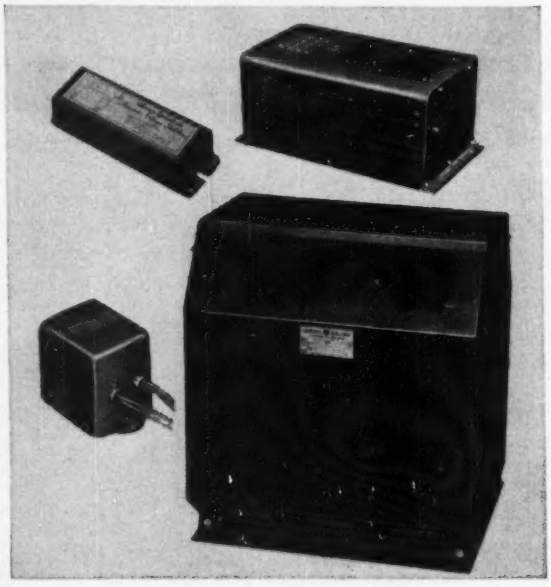
Built to withstand severe shock, these lightweight units operate over a wide temperature range (−55 C to +85 C and higher). Hermetic sealing protects them against leakage and contamination. Available in polar and non-polar construction, in ratings from 175 muf at 5 volts d-c to 12 muf at 150 volts d-c. For complete description of the line, plus application information, check Bulletins GEC-808 and GER-451 in the coupon on the next page.

*Trade-mark of General Electric Company.

Now—greater flexibility in voltage stabilizers

Fluctuating voltage is serious on sensitive electronic equipment designed for best performance at a specified voltage. Now, to help you get rid of voltage ups and downs, G.E. offers a new 15- to 5000-va line of automatic voltage stabilizers that gives you greater design flexibility at no increase in price, plus weight reduction in larger sizes. New output ratings of 1000, 2000, 3000, and 5000 volt-amperes—with 115 and 230 volts on both input and output—permit operation in any combination of these input and output voltages.

Fluctuations between 95 and 130 volts, or 190 and 260 volts, are corrected to a stable 115 or 230 volts within ±1 percent—and in less than two cycles. Single-core construction permits input circuit to be completely isolated from output circuit. Installation is easy: connect one set of terminals for supply and another set for the load. With no moving parts, maintenance is virtually eliminated. See Bulletin GEA-5754 for complete description.



GENERAL ELECTRIC

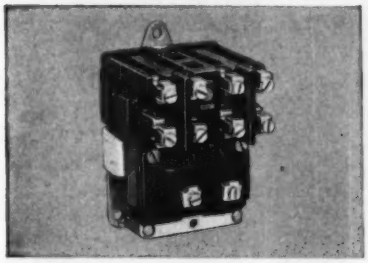
DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

Prices reduced as much as 35% on light, flexible delay line

Increased use of delay line in special circuits for electronic equipment now enables General Electric to mass-produce it, at savings to you of up to 35 percent. Originally developed to provide delay with minimum distortion in radar equipment, G-E delay line now has many commercial uses such as color television and electronic calculators.

Bulk line is available in lengths of 100 feet or less to be cut as desired. Time delay is approximately ½ microsecond per foot for 1100-ohm line, ¼ microsecond per foot for 400-ohm line. Line is light in weight, ¼-inch in diameter, and easily bent into a 4-inch diameter coil. Operates between −50 C and 100 C. Bulletin GEC-459.

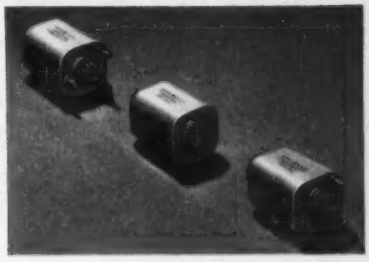


Size 00 relays cut inventories

Many of your control-circuit needs can be met with compact G-E size 00 contactors and relays—available in any combination of normally open and normally closed contacts from 2 to 8 poles. Since contact tips are easily changed from NO to NC without extra parts, your "specials" inventory is cut. Easily accessible terminals take up to 3 wires, speed connections. For complete details, see your General Electric apparatus sales representative.

Reliable d-c to a-c amplification

Designed mainly for 400-cycle excitation, the General Electric second-harmonic converter is a magnetic-amplifier type unit that converts low-level d-c error signals (such as thermocouple output) to 800-cycle a-c output. Static operation and hermetic sealing make it reliable under extreme conditions of acceleration, temperature, and pressure —important in aircraft applications. Length is $3\frac{1}{16}$ in., tube diameter $1\frac{1}{4}$ in., weight, 0.2 lb. See Bulletin GEC-832.



Now—sealed-relay line expanded

G-E hermetically sealed relays for 28-volt circuits are now available in these forms: DPDT, 3PDT, 4PDT, 6PNO—with coil ratings up to 10,000 ohms. Certain other configurations available on request. All have extra-high tip pressures, yet don't exceed Air Force-Navy size and weight specs. They withstand all outside atmospheric conditions, 50g operational shocks, and instantaneous voltage surges up to 1500 volts. Bulletin GEA-5729.

EQUIPMENT FOR ELECTRONICS MANUFACTURERS

Components		Development and Production Equipment
Meters, Instruments	Fractional-hp motors	Soldering irons
Dynamotors	Rectifiers	Resistance-welding control
Capacitors	Timers	Current-limited high-potential tester
Transformers	Indicating lights	Insulation testers
Pulse-forming networks	Control switches	Vacuum-tube voltmeter
Delay lines	Generators	Photoelectric recorders
Reactors	Selsyns	Demagnetizers
Thyrite*	Relays	
Motor-generator sets	Amplidynes	
Inductrols	Amplistats	
Resistors	Terminal boards	
Voltage stabilizers	Push buttons	
	Photovoltaic cells	
	Glass bushings	

*Reg. Trade-mark of General Electric Co.

General Electric Company, Section 667-24
Schenectady 5, New York

Please send me the following bulletins:

√ for reference only
× for immediate project

☐ GEA-5729 Sealed Relays
☐ GEA-5754 Voltage Stabilizers
☐ GEC-459 Delay Line
☐ GEC-808 & GER-451 Tantalytic Capacitors
☐ GEC-832 2nd-Harmonic Converter

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

Name_____

Company_____

City_____ State_____

Luxolene Green

a new advancement in moisture-resistant coils

Luxolene Green molded coils have been engineered especially for applications involving intense moisture conditions, such as in refrigeration, air conditioning, water pumping, etc. . . . also for explosion proof applications.
Field tests of production coils have proven more than satisfactory.
The cost of Luxolene Green encased coils is nominal. Send for complete information.

(NOTE: Deluxe Coils, Inc., manufactures coils only—no complete transformers, relays, solenoids, etc.)

ENGINEERING DATA

COIL CONSTRUCTION: Random, paper layer or precision wound.

Excellent Bond { Lead Wires 105°C Polyvinylchloride U.L. approved; Molding Compound—Luxolene Green Resin; Core Tube—Luxolene Green Resin } ONE HOMOGENOUS MASS

Operating Temperatures:

Continuous	−90° to +250°F
Intermittent, 4 hrs.	−90° to +300°F
Intermittent, 1 hr.	−90° to +400°F

Properties of Luxolene Green Resin:

Tensile strength	10,900 pSI
Water absorption	less than 1/10 of 1% after 24 hours immersion.
Thermal coefficient of expansion	6.1 x 10^{-5}
Thermal conductance	4.9 x 10^{-4}.
Volume resistivity	megohms CMS 10^{15}
Dielectric strength	400 volts, 1 mil
Arc resistance	95
Dielectric constant	10^{3} cycles 3.90; 10^{10} cycles 2.99
Loss factor	10^{3} cycles .0113; 10^{10} cycles .0252
Solubility	Attacked by concentrated sulphuric acid, but is resistant to concentrated hydrochloric acid. Trichlorethylene, ethylacetate and acetone will attack but not dissolve Luxolene.
Adhesion	Very strong to metal. Makes excellent bond with 105°C Polyvinylchloride lead wires.

LUXOLENE CERTIFICATION
EVERY SHIPMENT COVERED BY THIS CERTIFICATION:

LUXOLENE CERTIFICATION

Serial No. 0000

"We hereby certify that the coils covered by packing slip No..... have been immersed in water at room temperature for 24 hours. After immersion, with 500 volts D.C. applied, the leakage resistance through water to ground has been measured by standard procedures and found to be not less than 200 megohms.

DELUXE COILS, INC. 1304 First St., Wabash Ind.

presto change-o

If you're *not* using Presto discs at present, then it's time for a change. The reason, in one word . . . quality! From the meticulous preparation of the aluminum base in the Presto plant to the final play-back in the studio, quality is the byword . . . your assurance of consistent performance, unmatched fidelity of reproduction, long service. That's why Presto is the proven leader in the professional disc field . . . a leader that merits your consideration when you decide that it's time for a change . . . right now.

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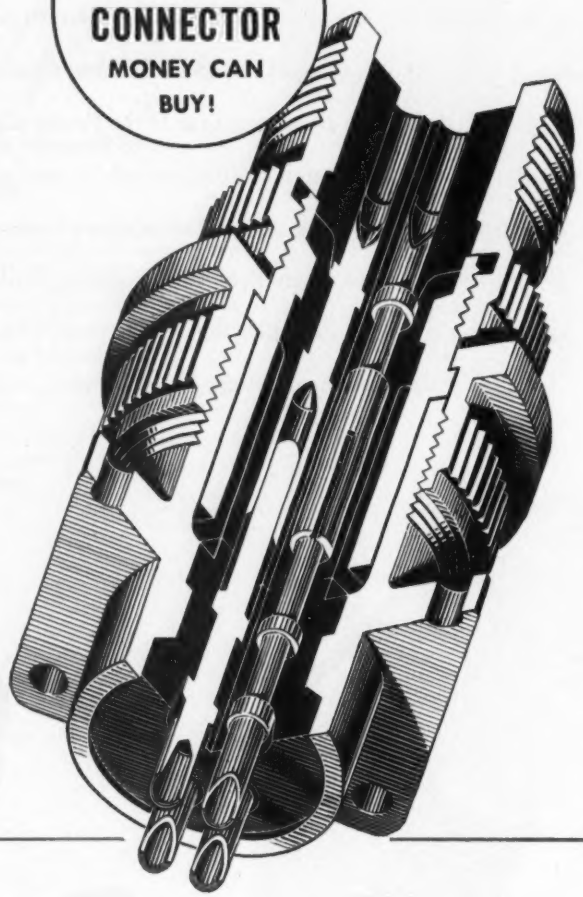
WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

SCINFLEX ASSURES
LOW MAINTENANCE BECAUSE
IT PERMITS SIMPLICITY

When operating conditions demand an electrical connector that will stand up under the most rugged requirements, always choose Bendix Scinflex Electrical Connectors. The insert material, an exclusive Bendix development, is one of our contributions to the electrical connector industry. The dielectric strength remains well above requirements within the temperature range of −67°F to +275°F. It makes possible a design increasing resistance to flashover and creepage. It withstands maximum conditions of current and voltage without breakdown. But that is only part of the story. It's also the reason why they are vibration-proof and moisture-proof. So, naturally, it pays to specify Bendix Scinflex Connectors and get this extra protection. Our sales department will be glad to furnish complete information on request.

• Moisture-Proof • Radio Quiet • Single Piece Inserts • Vibration-Proof • Light Weight • High Insulation Resistance • High Resistance to Fuels and Oils • Fungus Resistant • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required.

The Finest
ELECTRICAL CONNECTOR MONEY CAN BUY!



BENDIX SCINFLEX
ELECTRICAL CONNECTORS

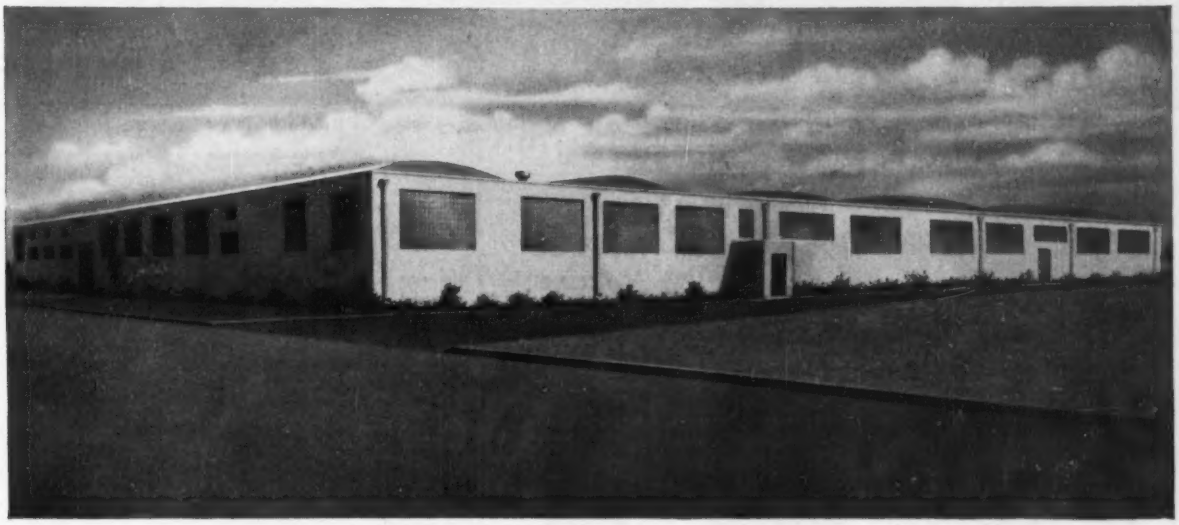
Bendix

SCINTILLA MAGNETO DIVISION of Bendix Aviation Corporation
SIDNEY, NEW YORK

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: **118 E. Providencia Ave., Burbank, Calif. • Stephenson Bldg., 6560 Cass Ave., Detroit 2, Michigan • Brouwer Bldg., 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California**

LITTON INDUSTRIES NEWS

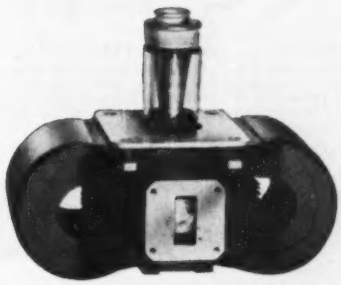


ANOTHER ADDITION TO LITTON PLANT TO HELP MEET YOUR TUBE DEVELOPMENT AND PRODUCTION NEEDS

Litton is now building a new addition to its vacuum tube plant at San Carlos, California. This expansion will approximately double tube development and manufacturing facilities and will allow expansion of our affiliate, Litton Engineering Laboratories, which has taken over the manufacture of glassworking lathes and other machine products. Like the plant completed last year, the new building has been designed specifically for vacuum tube manufacture; it has similar reinforced concrete block walls with large glass-block panels for diffused daytime illumination.

Included is complete environmental control of temperature, sound, light and air for optimum manufacturing conditions.

Increasing demand for Litton products has brought about this expansion, and we expect that the added capacity will provide greater volume and service to our friends in industry.



LITTON MAGNETRONS

Concurrent with plant expansion is a marked increase in the variety of pulse and CW magnetrons for radar, beacon and countermeasure equipment. It is quite possible that Litton Industries now has in production or development the specific tube to meet your needs.

Application of Litton design and processing criteria to all our tube types permits manufacture of tubes that require no aging racks in the plant or in the field and have long shelf life with snap-on operation to full rated power output immediately after completion of the cathode warm-up period.

2674

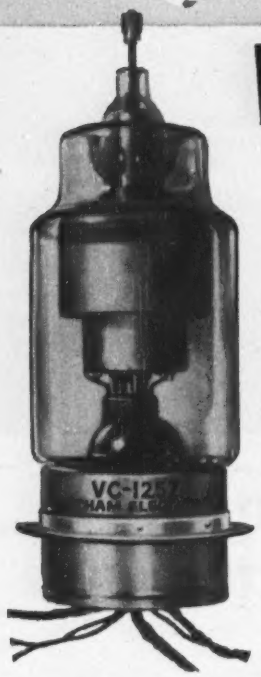
LITTON INDUSTRIES

Manufacturers of Vacuum Tubes and Accessory Equipment

1025 BRITTAN AVENUE • SAN CARLOS, CALIFORNIA • U. S. A.

CHATHAM
ELECTRONIC TUBES

Hydrogen Thyratrons
—for Pulse Voltage Generation



TYPE VC-1257
Hydrogen filled, zero bias thyratron with hydrogen generator for generation of pulse power up to 40 megawatts.

TYPE 5948/1754
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

TYPE 5949/1907
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

TYPE VC-1258
Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW.

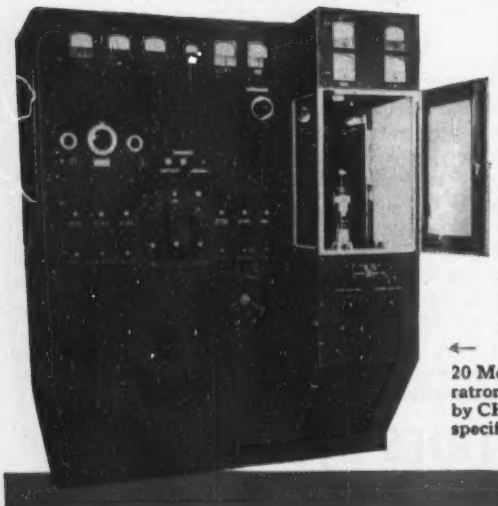
ELECTRICAL DATA*

Type	VC-1258	5949/1907	5948/1754	VC-1257
Maximum Peak Forward Anode Potential	1000 volts	25000 volts	25000 volts	38000 volts
Maximum Peak Anode Current	20 amps	500 amps	1000 amps	2000 amps
Maximum Average Anode Current	0.05 amps	0.50 amps	1.0 amps	2.0 amps
Maximum Heating Factor (epy x prr x ib)	1.0×10^8	6.25×10^9	9.0×10^9	—
Nominal Filament Power	12.6 watts	95 watts	190 watts	230 watts
Hydrogen Reservoir	No	Yes	Yes	Yes

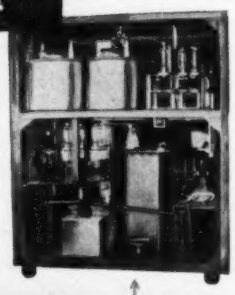
*More detailed information on electrical and mechanical data will be supplied on request.

● A NEW CONCEPT OF HYDROGEN THYRATRON DESIGN! The tubes illustrated represent a departure from conventional hydrogen thyratron designs and are a result of several years of concentrated development work. They are primarily employed in the generation of peak voltages with durations in the order of microseconds.

Custom-built Electronic Equipment

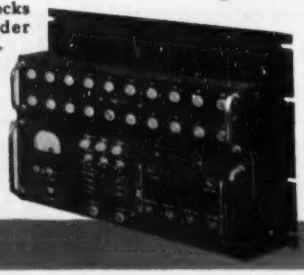


● CHATHAM specializes in the development, design, and construction of custom-built electronic equipment to exactly meet customers' requirements. Our capable staff of engineers will furnish prompt estimates or, if desired, will call to discuss your problem personally. Call or write today.



5 Megawatt radar modulator built by CHATHAM to rigid government standards.

Pulse life test equipment built by CHATHAM checks receiver type tubes under pulse conditions. →



← 20 Megawatt Hydrogen Thyratron Test Equipment built by CHATHAM to customers' specifications.

ELECTRONICS AND EQUIPMENT

Electronic Tubes

Ruggedized Type Tubes

● The following tubes fully conform to JAN specifications and can be supplied promptly, usually direct from stock:

5R4WGY	2D21W
6AL5W	OC3W
6H6WGT	OD3W
25Z6WGT	2050W

TYPE 719-A HIGH VACUUM CLIPPER DIODE

This tube is used primarily for clipper diode service in hard tube modulator circuits. Filament 7 volts, 7 amps... Inverse peak anode voltage 25 kv, Max., peak anode current 10 amps, Max., anode dissipation 75 watts.

TYPE 1Z2 RECTIFIER

A small bulb high voltage vacuum rectifier. Low cathode heating power and low dielectric losses make tube suitable for radio frequency supply circuits. Filament 1.5 volts, .290 amps... Inverse peak anode voltage 20,000, average plate current 2 ma.... peak plate current 10 ma.

TYPE 1B46 REGULATOR

A cold cathode glow discharge tube designed for voltage stability. DC operating voltage 82 volts, operating current range 1 ma minimum, 2 ma maximum. Regulation 3 volts.

TYPE 395-A COLD CATHODE GAS TRIODE

Requires no filament supply and is used in many grid controlled rectifier and relay applications.
Maximum D.C. anode current—10 ma.
Maximum D.C. anode voltage—150 volts

TYPE 4B32 RECTIFIER

A rugged half-wave Xenon filled rectifier. Operates in any position throughout an ambient temperature range of −75°C to +90°C. Filament 5 volts, 7.5 amp... Inverse peak anode voltage 10,000 average anode current 1.25 amps.

TYPE 394-A THYRATRON

A Mercury vapor and Argon filled thyratron for grid controlled rectifier service. Operates over wide ambient temperature range. Heater 2.5 volts, 3.2 amps... Inverse peak anode voltage 1250, average anode current 640 ma.

TYPE 3B28 RECTIFIER

This rugged half-wave Xenon filled rectifier will operate in any position and throughout an ambient temperature range of −75°C to +90°C. Filament 2.5 volts, 5.0 amps... Inverse peak plate voltage 10,000, average anode current .25 amp.

Chatham Vacuum Switches

● TYPE 1S22 (illustrated) is a mechanically actuated, single-pole, double-throw, glass vacuum switch. This and other types can be supplied.

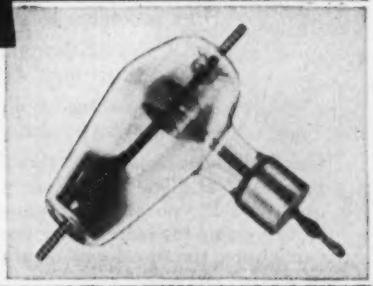
SPECIFICATIONS

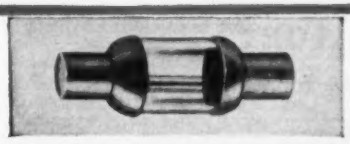
HOLD OFF VOLTAGE: Internal—10,000 volts rms; External* (at 27,000 feet altitude)—10,000 volts rms; External* (at 40,000 feet altitude)—7,500 volts rms.

INTERRUPTING RATING, RESISTIVE LOAD: 1,000 operations life at 10,000 v, ac, rms—10 amp, ac, rms; 1,000,000 operations life at 10,000 v, ac, rms—2 amp, ac, rms; 500,000,000 operations life at 10,000 v, ac, rms—0.1 amp, ac, rms.

NET WEIGHT (approx.) ..... 2 ozs.
MAXIMUM LENGTH (overall) ..... 3⅝ ins.
MAXIMUM WIDTH (overall) ..... 4 1/16 ins.
MAXIMUM THICK. (overall) ..... 1 1/16 ins.

*at 50% humidity





HIGH VOLTAGE VACUUM FUSES

Can be supplied by Chatham to exact customers' specifications if ordered in adequate quantity. Call or write for full particulars and quotes.

CHATHAM ELECTRONICS CORP.
475 WASHINGTON STREET • NEWARK 2, NEW JERSEY

MALLORY TYPE XT
TANTALUM ELECTROLYTIC CAPACITORS

MFD	SIZE D	SIZE H	C	OHMS	200°C MAX. Type No.	DCV	μA	150°C MAX. Type No.	DCV	μA	125°C MAX. Type No.	DCV	μA	85°C MAX. Type No.	DCV	μA
120 240	⅜ 1⅛	½ ⅝	1 1	2.5 2.5	XT120-12 XT240-12	12 12	80 80	XT120-14 XT240-14	14 14	90 90	XT120-15 XT240-15	15 15	100 100	XT120-18 XT240-18	18 18	125 125
75 150	⅜ 1⅛	½ ⅝	1 1	2.5 2.5	XT 75-20 XT150-20	20 20	80 80	XT 75-23 XT150-23	23 23	90 90	XT 75-25 XT150-25	25 25	100 100	XT 75-30 XT150-30	30 30	125 125
40 80	⅜ 1⅛	½ ⅝	1 1	2.5 2.5	XT 40-38 XT 80-[illegible]	[illegible]								XT 40-60 XT 80-60	60 60	125 125
25 30	⅜ 1⅛	½ ⅝	1 1	2.5 2.5	XT [illegible]									[illegible]-100 [illegible]100	100 100	125 125
12 25	⅜ 1⅛	17/32 15/16	2 2	5. 5.										[illegible]80 [illegible]180	180 180	125 125
8 16	⅜ 1⅛	1 3/16 1 5/16	3 3	7.5 7.5										XT 8-270 XT 16-270	270 270	125 125
6 12	⅜ 1⅛	1 17/32 1 21/32	4 4	10. 10.	XT 6 XT 12-2[illegible]									XT 6-360 XT 12-360	360 360	125 125
5 10	⅜ 1⅛	1 29/32 2 1/32	5 5	12.5 12.5	XT 5-300 XT 10-300	[illegible]		XT 10-37[illegible]			[illegible]100		100	XT 5-450 XT 10-450	450 450	125 125
4 8	⅜ 1⅛	2 1/32 2 1/32	6 6	15. 15.	XT 4-360 XT 8-360	360 360	80 80	XT 4-450 XT 8-450	450 450	90 90	[illegible]-480 XT 8-480	480 480	100 100	XT 4-540 XT 8-540	540 540	125 125
3.5 7.	⅜ 1⅛	2 11/32 2¼	7 7	17.5 17.5	XT 3.5-420 XT 7-420	420 420	80 80	XT 3.5-525 XT 7-525	525 525	90 90	XT 3.5-560 XT 7-560	560 560	100 100	XT 3.5-630 XT 7-630	630 630	125 125

Case Sizes from ⅝" x ⅞"

The Mallory Tantalum Capacitor shown is but one of the complete range of sizes and ratings indicated in the table. Note the following advantages:

Compactness

Continuous performance over a temperature range of –60° C. to +200° C.

High resistance to shock and vibration

Proof against thermal shock from –60° C. to +200° C. without damage

Double sealing for absolute protection under all operating conditions.

Originally developed for the Armed Forces subminiaturization program, Mallory Tantalum Capacitors are now available in quantity. If you are redesigning your equipment, don't hesitate to call on us for help in any problem involving the application of capacitors, the development of special types or the simplification of related circuits.

For Complete Information...

The above table is part of our new Technical Bulletin 4-3. Write for your copy today. It is complete with sizes, mounting arrangements, surge voltages and performance curves.

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CROSS TALK

►**VISION** . . . As we enter the age of transistors it is important that engineers open their eyes wide to the potentialities of these new devices that are like tubes and yet are not like tubes. Circuits can be developed by thinking of transistors as substitutes for tubes. But more important circuits will come from the harnessing of characteristics that are peculiar to transistors themselves.

It is, for example, possible to build an audio amplifier that contains junction transistors and nothing much else in the way of component parts. The output of a phonograph pickup is fed into an n-p-n and also into a p-n-p junction. "Complementary symmetry" of the two dissimilar transistors permits this first stage to be direct-coupled to another pair of n-p-n and p-n-p junctions so connected that they drive a loudspeaker without benefit of an output transformer. Phase inversion and impedance matching are inherent in the system, and are accomplished by phenomena that have no counterpart in the terminology of tubes.

In the spring ELECTRONICS begins a carefully planned series of articles dealing with the basic characteristics of semiconductors in general and transistors in particular. This series will appear side by side with detailed descriptions of practical transistor circuits as these are developed. The double-pronged editorial approach to a new horizon will, we think, provide a solid base upon which men with imagination can build.

►**MONOPOLY** . . . We are also entering an era in which no one amplifying device will monopolize the expanding field of electronics. Tubes will share it not only with transistors and magnetic amplifiers but also with other devices as yet largely a gleam in some physicist's eye.

Time alone will tell which device is to dominate what equipment. Meanwhile, it does seem that tubes are at their shining best where high power is required at high frequencies and, particularly, where complex broadband modulation components are involved. This, at any rate, is the area in which much current development work is going on, sparked to a considerable extent by the increasing demands of uhf television.

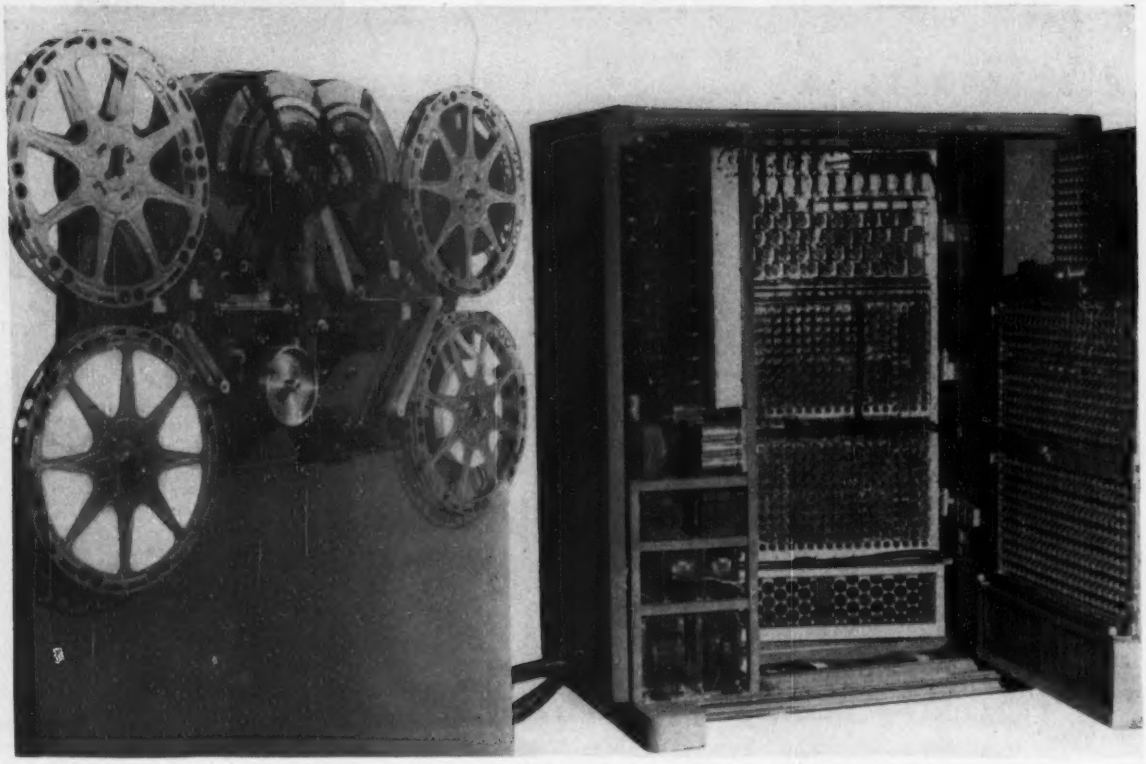
Much is being done to increase the usefulness of klystrons. A new magnetron incorporating a grid exhibits considerable flexibility. Traveling-wave tubes tuneable over a moderate frequency range by mere variation of operating voltages show experimental promise. There is a great deal of constructive thinking going on in the laboratories of highly competitive tube manufacturers.

►**MISTAKE** . . . Our whole field is unusually active technically, and the future seems bright. All is not sweetness and light on the sales front, however, and there is one part of the business that has recently acquired a beautiful black eye from which it will take some time to recover.

It seems that an active microwave-relay equipment market attracted some manufacturers who either cut design corners to get into the game quickly or spaced stations too far apart on paper to hold price down and get the order. Now some of the stuff doesn't work too well when transmission conditions are ideal and falls down completely when they are poor. Several installed systems are unused and just gathering dust.

►**PICTURE** . . . If you are wondering whether the admittedly flattering photograph at the top of this page is to be a regular eyesore then wonder no more. The answer is, quote: "No."

The subject of the picture has been active in management and sales as well as in technical circles of this industry since 1924, with McGraw-Hill since 1926 and ELECTRONICS since 1941. He was appointed editor January 1, just after the preceding issue mailed. The thought therefore occurred that there may be two or three of the paper's thirty-some-odd-thousand subscribers who wonder what the editor looks like, a condition to be personally rectified in the years ahead as rapidly as flesh and blood, a liberal travel budget and time permit.



Multiple-stylus printer has punch-card feed and photoelectric card reader located behind printing unit (left). Electronic unit converts punch-card data to impulses that drive printing styli

Electronic Addressing

Computers and high-speed printers team up to rush publications to readers. Multiple-stylus machine works directly from punch cards and prints up to 42,000 individual four-line address labels per hour

LIFEBLOOD of a publication is its readership.

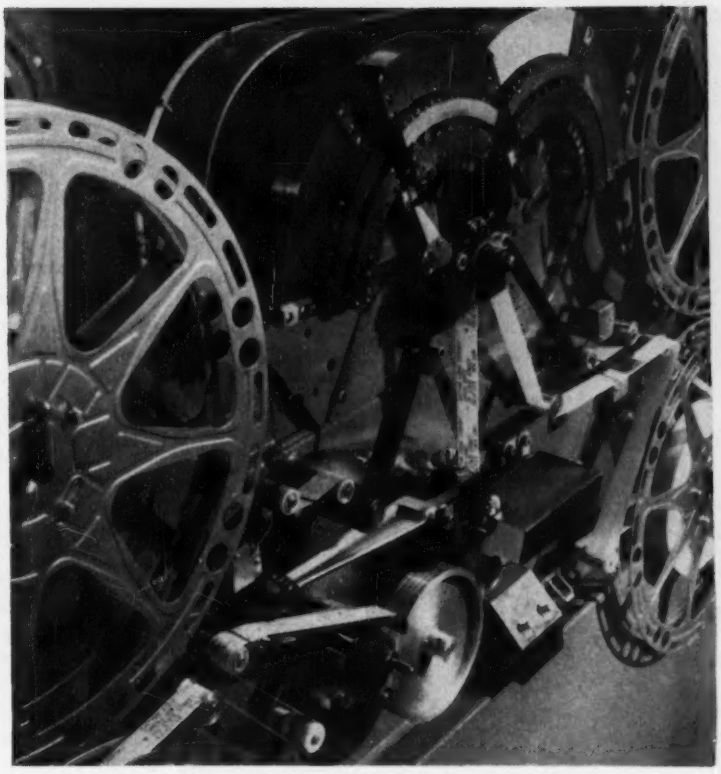
To serve the reader, the subscription-fulfillment department keeps lists current and mails each copy promptly. This involves storing and servicing vast quantities of data as well as printing many thousands of individual address labels for each issue of the publication. Electronic equipment is proving adept at both chores, particularly for publications having large mailing lists.

Currently in use is a facsimile printer[1] made by Addressograph-Multigraph, that works from printed address cards and has a capacity of 6,000 four-line address labels per hour. The address cards are helically scanned by a phototube linked mechanically to the printing bar. Relays are so adjusted that the printing bar strikes when the phototube receives a black signal. Nearly 100 machines are in use.

Multiple-Stylus Printer

A recent addition to the field, the multiple-stylus electronic printer[2], works directly from punch cards and prints up to 42,000 four-line address labels per hour. Developed by Eastman Kodak, the machine is used in that company's advertising and direct-mail department to service extensive mailing lists.

Printing speed depends upon the number of printing heads used and may be increased 24,000 characters per minute with each additional printing head. The present model uses four heads, one for each line of the address. Individual char-



Printing styli strike impact blows on paper through carbon; each of four printing heads prints one line of address

Aids Publishers

By JOHN M. CARROLL

Assistant Editor
ELECTRONICS

acters are built-up by printing rectangular dots in a 5 × 7-dot rectangle to form a pattern. Synthesis by this method of the letter *E* is shown in Fig. 1A.

Use of a fixed card carrying city and state names common to many cards increases address-card information capacity and eliminates repetitive card punching.

Each printing head consists of seven styli actuated by multiple vibrators. The styli print rectangular dots by striking impact blows on carbon paper. They are released in the desired pattern by independent relays working in accordance with signals received from an electronic matrix. Carbon impressions are fixed by drying lamps and a flying punch pierces holes between address labels. The close-up shows the printing operation. The four printing heads are arranged in a semi-circle at the top of the picture.

Information to be printed is stored on punch cards like those shown in Fig. 1B. A punch card for a four-line address of 96 characters must have 576 holes arranged in 48 columns of 12 holes each. The card is quartered, each quarter corresponding to one line of the address (24 characters). Characters are expressed in six-unit code and represented by holes punched in the card.

Punch cards are fed to the printer in batches of 700. Reading is done photoelectrically by four independent reading heads that correspond to the four lines of the address. Each head has six lead-sulphide photocells, so that all places of the six-unit code groups are read simultaneously by light shining through the punched holes.

Timing pulses are supplied by a slotted wheel that rotates in synchronism with the card feed and interrupts the light beam falling on another photocell.

Each reading head transmits a group of pulses as a card column passes. These pulse groups are amplified, gated by the timing pulses to insure exact synchronism and fed to the storage matrix.

The matrix has 96 memory sockets, each one corresponding to a possible character in a four-line address. The sockets are arranged in four banks of 24, the same as the code groups on the punch card. A memory plug consisting of seven magnetic memories is inserted in every memory socket from which a printed character is desired.

Pulse groups from the reading heads are channeled into the storage bank corresponding to the proper line of the address. Meanwhile, the timing pulses are applied to step a ring circuit that delivers actuating pulses to successive memory units in exact synchronism with the card reading. Six of each memory unit's magnetic memories are used to store code signals representing characters while the seventh memory forms part of an error-detection system.

Printing

A second slotted wheel rotating in synchronism with the printing unit generates a series of seven pulses for each character to be printed. These pulses drive a seven-tube ring circuit. Every seventh pulse steps a second ring circuit that applies simultaneous read-out pulses successively to the

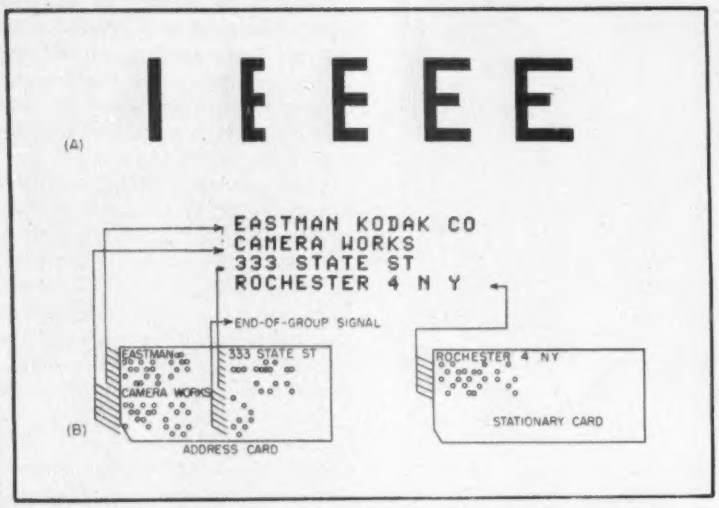


FIG. 1—Letter *E* is built up on 35-dot matrix (A) in five blows by printing styli. Punch cards (B) are quartered to give four-line address of 24 characters per line. Alphabetical and numerical characters are expressed in six-unit code

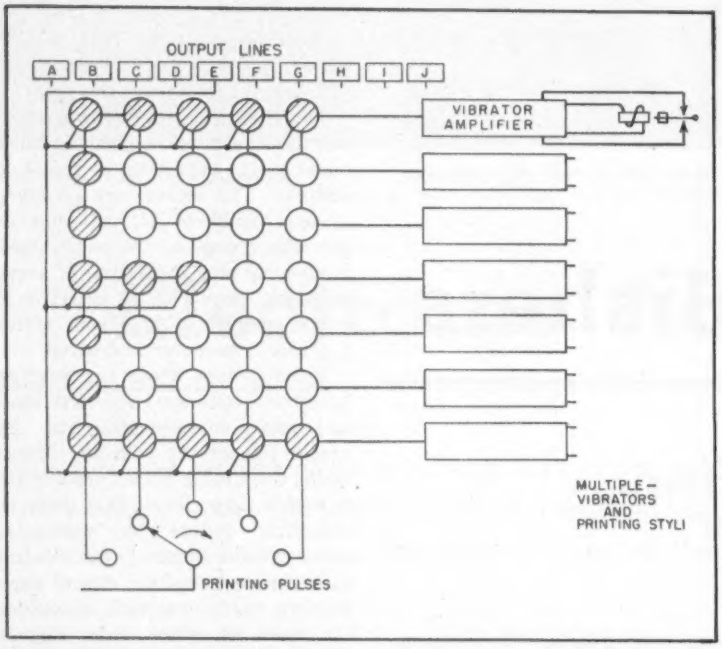


FIG. 2—Output lines from decoding matrix select pattern of switch combinations corresponding to desired character. Switch matrix columns are read out by five of the seven printer timing pulses

memory units in each of the four storage rows.

As each memory unit is read out, its signals go to one of four line-printing units where the signals are first applied to a group of six flip-flops. A trigger signal is set up for each pulse from the memory unit. The trigger signals are connected to a germanium-diode decoding matrix in such a manner that for every different pulse-code group a unique output line is selected that corresponds to the printed character desired.

Each output line connects to a 5×7 matrix of 35 switches (Fig. 2). When an output line is energized, certain of the switches close to form the pattern of the character to be printed. Consider the switch matrix to consist of five columns of seven switches each.

A printer timing pulse feeds into each of the five matrix columns in turn. A separate vibrator amplifier is connected to each row of seven switches and as each column is pulsed, a signal is sent to every amplifier whose switch in the column is closed. Each vibrator amplifier is connected to a vibrator that activates one of the seven printing styli. The paper tape advances one dot space as each column is pulsed and the character is built up in five pulses. The fifth pulse resets the trigger tube for the following character.

Over the Horizon

Several other methods of electronic subscription fulfillment are under study. The Potter Instrument Co. is working on a system in which their flying typewriter[3], its tube complement now reduced to 300, teams with a random access memory (RAM) to print 10,800 address labels per hour per printer. The random access memory is the outstanding feature of the system. Over a million subscription records can be stored magnetically and each day's transactions entered without disturbing the unaffected records. Serial tape-handling systems require that the entire tape be rearranged when subsequent transactions are to be filed.

Another proposed method would display information from a storage device on the screen of the Charactron[4, 5], a cathode-ray tube with a beam-forming matrix of character-shaped openings through which the electron beam is directed. Addresses, displayed at rates up to 10,000 per sec on the crt face, can be transferred to ordinary paper by a dry-printing process such as Xerography.

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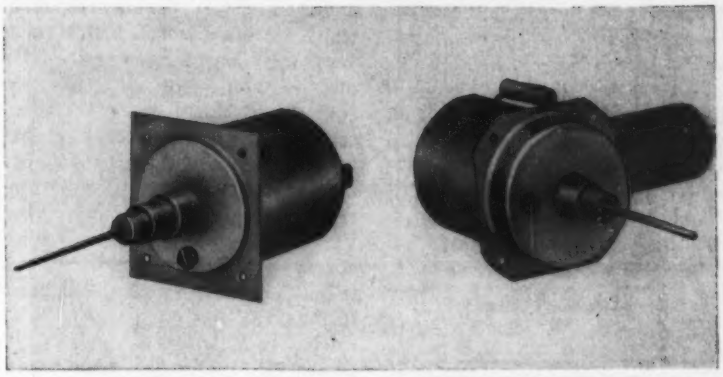
(3) J. J. Wild, High-Speed Printer for Computers and Communications, ELECTRONICS, p 116, May 1952.
(4) J. T. McNaney, Data-Displaying Cathode-Ray Tube, ELECTRONICS, p 174, Aug. 1952.
(5) J. T. McNaney, The Charactron, *IRE National Conference paper*, May 1952.

By HENRY FOGEL*

and

SEYMOUR NAPOLIN

Radio Receptor Co.
Brooklyn, N. Y.



Tuning elements for preselector and oscillator employ plungers

Cavity Tuner for UHF Television

All 70 of the high-band channels are continuously tuned by varying the center-loading capacitance of a modified coaxial line section. Design avoids moving contacts and minimizes radiation from oscillator by inherent shielding

DEVELOPMENT of a tv receiver front-end to cover the uhf channels imposes severe requirements. After consideration of butterfly arrangements, coaxial lines with wiping contacts or capacitors and other devices, a modified resonant cavity was adopted as the basic tuning element.

The tuner shown in the diagram, Fig. 1, contains three cavities. Two of these function as a bandpass preselector and the third controls the local oscillator frequency. The preselector is essentially an overcoupled double-tuned transformer with a balanced 300-ohm antenna input and unbalanced output to the mixer.

Tuning of each cavity is accomplished by a metallic plunger traveling in a low-loss dielectric sleeve which varies the value of center loading capacitance. The plunger serves only as a transfer medium and makes no physical contact with the cavity or loading capacitor.

Suitably formed loops couple in and out of the cavity field with the degree of coupling controlled by physical dimensions and placement. The tuning plungers are ganged together and moved by a simple linkage that provides substantially linear frequency calibration. Dial and inter-cavity tracking are adjustable at three points by positioning the plunger, trimming the loading capacitance and by an additional mechanical means of changing the electrical length of the cavity.

The view of the complete converter shows the three cavities assembled to a small subchassis, with their tuning plungers attached to the ganged drive. This drive consists of a metal frame pivoted at one end and swung in an arc by a link mechanism against a spring.

Straight-line motion is imparted to the plungers by the rotation of the frame. The dial is concentric with the tuning knob and calibrated

Now with Granco Products, Inc., Long Island City, N. Y.

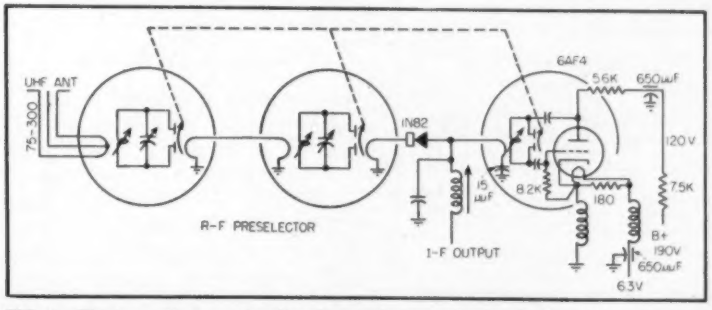


FIG. 1—Three cavities are employed, two for preselection and one for the local oscillator

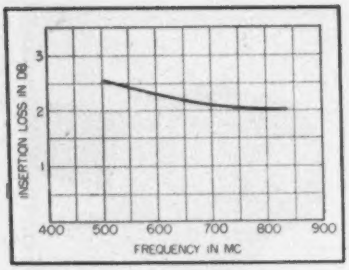


FIG. 2—Insertion loss for two cavities plotted against frequency

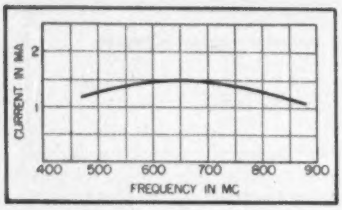


FIG. 3—Crystal injection current is nearly constant over the frequency range

directly in channel numbers. A metal wrap-around encloses the entire unit to guard against mechanical damage during handling, and act as a second r-f shield to reduce radiated interference.

The local oscillator, a Colpitts type, tunes below the signal frequency for double superheterodyne or converter applications. Mixing takes place in a low-noise diode, with the i-f signal appearing at vhf channels 5 or 6.

Tuning is controlled by a single knob which functions as both a channel selector and fine-tuning control. The complete uhf television band is covered by five turns of the tuning knob. A circular dial, linearly calibrated, rotates approximately 150 degrees.

In Fig. 1, the resonant cavity tuning elements are represented schematically by their lumped-constant equivalents to facilitate circuit analysis. Balanced 300-ohm antenna coupling is achieved simply by a loop located in the cavity field. Since the coupling is almost constant over the entire tuning range, antenna mismatch losses are minimized.

Selectivity

The skirt selectivity requirements at uhf are more severe than for vhf because of the relatively close spacing of signal and image frequencies and the multiple spurious responses which result from double conversion. Considerable selectivity may be obtained by using three or four tuned circuits; however, because of increased insertion loss and tracking errors, improvement in selectivity is accompanied by rapid degradation of noise figure. Fortunately, because of the high operating Q's possible at uhf, two tuned circuits provide adequate image and i-f rejection.

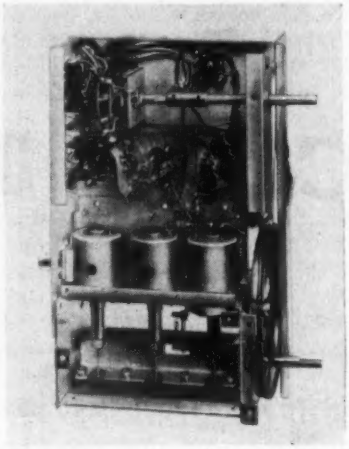
The double-tuned preselector shown has an image ratio better than 60 db, an i-f (80 mc) rejection greater than 90 db, with an insertion loss of approximately 2 db at 890 mc. A plot of insertion loss versus frequency is given in Fig. 2.

Radiation

Another measure of the effectiveness of a preselector is the value of end-to-end feed-through capacitance which generally determines the amount of oscillator voltage appearing across the antenna terminals. The preselector coupling throughout the tuner is primarily magnetic, and capacitance feed-through is reduced to negligible proportions. The attenuation at oscillator frequency is in the order of 45 db, which means that antenna radiation due to back-to-front coupling is less than 100 μv per meter.

Another source of oscillator radiation, that due to coupling around the preselector by stray magnetic and electrostatic fields, is minimized by careful layout and fully shielded construction, which effectively confines the r-f and oscillator fields within the metallic cavity walls.

A 1N82 low-noise silicon diode is used as a mixer. Diode rather than triode conversion was selected because better noise figures are possible, and as a result of the small injection voltages required, oscillator radiation is considerably reduced. In addition, the loose coupling between oscillator and mixer permits more stable oscillator performance. The preselector and oscillator outputs are linked by a common coupling loop which combines the fields of both cavities at the mixer input.



Ganged plungers move in and out of the cavities for tuning the complete uhf range

Oscillator Circuit

The 6AF4 local oscillator tunes below the carrier, to prevent reversal of the sound and picture position on the i-f response curve of the television receiver during double

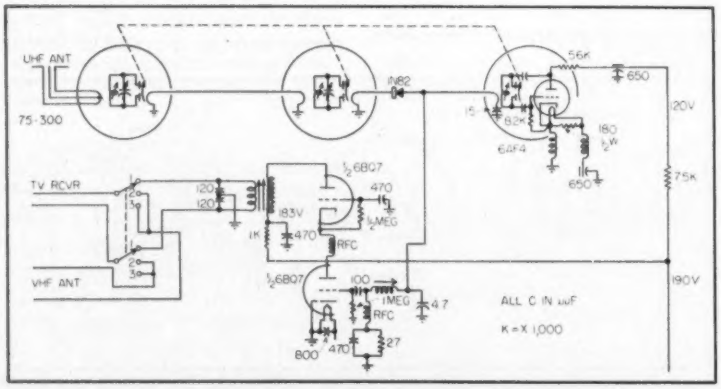


FIG. 4—Converter circuit includes cascode i-f stage

conversion. To assure stable oscillator performance all circuit elements are designed as an integral part of the resonant cavity, which results in almost constant injection current as shown in Fig. 3. This helps confine the oscillator field and substantially reduces radiated interference.

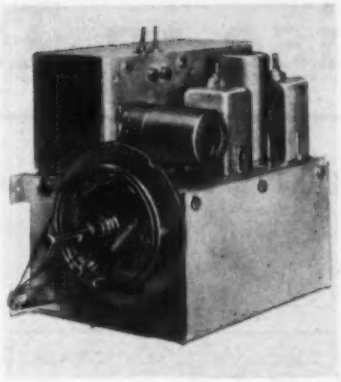
Although the uhf oscillator operates at a much higher frequency than a vhf oscillator, the permissible frequency drift on an absolute basis must be much smaller. This is the direct result of double superheterodyne operation, in which the additive drift of two local oscillators determines the overall frequency stability of the uhf receiver. Theoretically, assuming that the vhf tuner designer has taken full advantage of the permissible drift tolerance, the uhf oscillator must either be absolutely stable, or have a drift characteristic opposing that at vhf.

Fortunately, modern vhf tuners operate well within the allowable drift tolerance, and the television industry, in anticipation of the severe uhf requirements, is now producing sets using intercarrier sound circuits. While this eliminates the possibility of complete loss of sound due to drift, picture quality degradation and loss of sensitivity still remain.

Two factors generally influencing oscillator frequency stability are temperature changes and power supply fluctuations. The tuner local oscillator contains a temperature-sensitive element which varies the electrical length of the cavity, and holds the frequency substantially constant over a wide temperature range. Voltage sensitivity is reduced to a second-order effect by circuit design, and a regulated supply is therefore unnecessary for normal applications.

Output Frequency

For practical design purposes, vhf channels 5 and 6 were chosen as the intermediate frequency. Despite the fact that it is possible to receive weak transmissions in some scattered geographical locations on both these channels, high i-f attenuation through the tuner still permits interference-free uhf reception. Since the output tuned circuit is sufficiently broad to pass both channels, no readjustment of the oscillator is necessary to shift frequency, in the presence of strong local signals.



Cavituner is completely shielded front-end for uhf

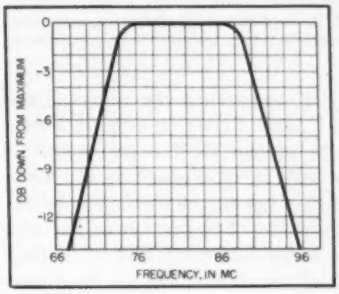


FIG. 5—Overall i-f response curve of converter

For those applications where the tuner is combined wtih a specially designed vhf tuner as an 82-channel front-end for new television receivers, no significant improvement in either noise figure or isolation can be expected from the addition of an i-f amplifier.

When used as a tuner or converter for existing television receivers, improved performance can be realized by the insertion of a cascode amplifier between the tuner output and the receiver input. Such a low-noise stage would provide needed gain, allow the tuner noise to dominate that of the vhf receiver, and further isolate the uhf and vhf oscillators. The individual tuning element is a modified, coaxial line section shorted at both ends, and center loaded by lumped capacitance to attain the necessary electrical length within small practical dimensions.

The complete circuit of a converter using the tuner and a cascode i-f amplifier is shown in Fig. 4.

The 6BQ7 cascode i-f amplifier has a noise figure of 6 db and power gain of approximately 15 db. Three tuned circuits are used to give a uniform response from 76 to 88 mc (channels 5 and 6) with relatively steep skirts to prevent spurious responses at vhf image frequency, and to sharply attenuate vhf oscillator feedback to the converter. Because of the broad flat-top response, no retuning is required whenever an alternate channel is selected.

An overall i-f response curve is shown in Fig. 5. Both the i-f response and power gain were measured with a 175-ohm generator to simulate the i-f impedance of the diode mixer. Layout and wiring of i-f connections to the mixer minimize parasitic "suck-outs" which adversely effect oscillator injection current.

Figures 6 and 7 provide supplementary data on bandwidth and noise figure.

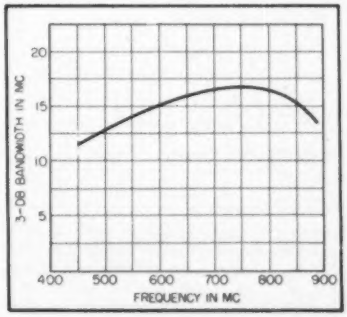


FIG. 6—Overall 3-db bandwidth for converter

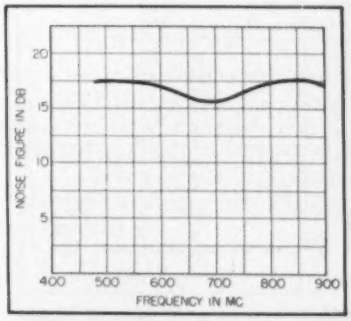


FIG. 7—Noise figure over the tuning range

Noise in Transistor

By EDWARD KEONJIAN and JOHANNES S. SCHAFFNER

General Electric Company
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TRANSISTOR NOISE differs from other types such as thermal and shot noise, since the transistor noise power per unit bandwidth is approximately inversely proportional to frequency. Figure 1 shows this variation of the noise power per cycle bandwidth with frequency. One consequence of this type of noise spectrum is that each octave of the frequency range contains the same noise power.

In the equivalent circuit representation of the transistor it is convenient to represent the noise by adding two noise-voltage generators with rms voltages E_{ns} and E_{nc} as shown in Fig. 2. It is then assumed that the other elements of the equivalent circuit are noiseless.

Representative values for E_{nc} and E_{ns} for point-contact transistors are 100 μv and 1 μv respectively, measured at a frequency of 1,000 cps for a bandwidth of one cycle. Corresponding voltages for junction transistors are 5 μv and 0.05 μv respectively.

For practical applications, it is more convenient to express the noise characteristics of the transistor by giving its noise figure. The noise figure is defined as the ratio of the total noise power in the output (disregarding the noise originating in the load impedance) divided by that portion of the output noise that results from thermal agitation in the source resistance R_g. This noise figure provides a convenient way of comparing the noise properties of transistors.

This paper will appear in the *NEC Proceedings* for 1952.

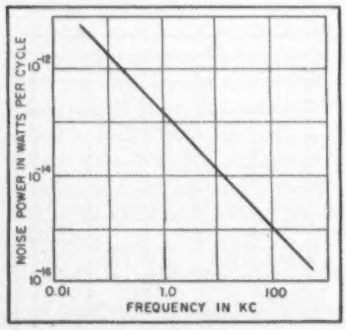

FIG. 1—Inverse relationship of transistor noise power per unit bandwidth and frequency

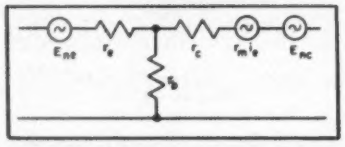

FIG. 2—Equivalent circuit of transistor including two noise-voltage generators

Figure 3 shows the variation of noise figure with frequency for two junction transistors. Representative values for noise figures, measured at a frequency of 1,000 cps are 40 to 60 db for point-contact transistors and 10 to 25 db for junction types transistors. Figure 4 shows the distribution of noise figure for 60 transistors of both types.

Mathematically, the noise figures for the three basic types of amplifier circuits may be expressed as follows: For grounded emitter

$$F = 1 + \frac{1}{4KTBR_g}\left[E_{ns}^2\left(\frac{R_g + \alpha r_c + r_b}{\alpha r_c - r_e}\right)^2 + E_{nc}^2\left(\frac{R_g + r_b + r_e}{\alpha r_c - r_e}\right)^2\right] \quad (1)$$

For grounded base

$$F = 1 + \frac{1}{4KTBR_g}\left[E_{ns}^2 + E_{nc}^2\left(\frac{R_g + r_e + r_b}{\alpha r_c + r_b}\right)^2\right] \quad (2)$$

For grounded collector

$$F = 1 + \frac{1}{4KTBR_g}\left[E_{ns}^2\left(\frac{R_g + r_e + r_b}{r_e}\right)^2 + E_{nc}^2\left(\frac{R_g + r_b}{r_e}\right)^2\right] \quad (3)$$

In these equations α, r_e, r_c, r_b and r_m are equivalent circuit parameters for the transistor. E_{ns} and E_{nc} are open-circuit voltages, R_g is source resistance, B is frequency band, K is Boltzmann's constant ($= 1.347 \times 10^{-23}$), and T is temperature in deg Kelvin. The addition sign in these equations expresses addition with attention to any correlation between E_{ns} and E_{nc}. If no correlation exists, then this operation may be replaced by simple addition.

The noise figure of a transistor depends on the operating point. For example, while the emitter noise is almost independent of the collector voltage V_c, the collector noise depends strongly on it. Figure 5 shows variation of the collector noise voltage for one-cycle bandwidth with the collector voltage V_c. The noise figure for point-contact transistors is almost independent of the collector voltage V_c as shown by the experimental curves in Fig. 6.

The noise figures of some junction transistors display the same independence of the collector voltage. The noise figure for most junction transistors, however, decreases with decrease in collector voltage, as shown in Fig. 7. Figure 8 shows the contributions to noise figure by the emitter and collector together with total noise figure. It is, therefore, necessary to operate the transistor at collector voltages falling into region A of Fig. 8.

Signal-to-Noise Ratio

The total noise power in a frequency band $f_2 - f_1$ is

Amplifiers

Particular recommendations for obtaining the optimum signal-to-noise ratio in point-contact and junction transistor amplifiers. Typical values and curves show how this type of noise figure varies with operating point of transistor and source impedance

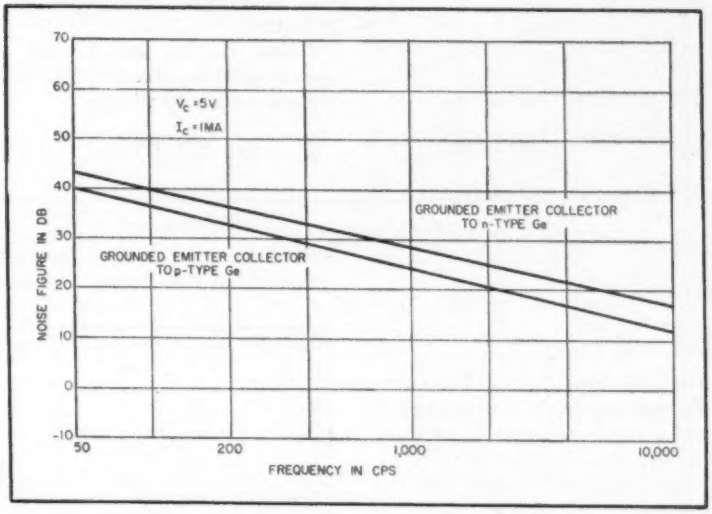

FIG. 3—Variation of noise figure with frequency for two different types of junction transistors

$$\int_{f_1}^{f_2} \frac{K}{f}\,df = K \ln \frac{f_2}{f_1} \qquad (4)$$

On the other hand, the thermal noise power due to R_g is proportional to the bandwidth $f_2 - f_1$. The noise figure for the bandwidth limited by the frequencies f_2 and f_1 is

$$F = 1{,}000\, F_o\, \frac{\ln f_2/f_1}{f_2 - f_1} \qquad (5)$$

where F_o is the noise figure at 1,000 cps for a bandwidth of one cycle. If

$$f_2/f_1 \leqq 1$$

then

$$\ln \frac{f_2}{f_1} \leqq \frac{f_2 - f_1}{f_1}$$

and

$$F \leqq F_o \frac{1{,}000}{f_1} \qquad (6)$$

The noise figure may be considered fairly independent of the bandwidth if this bandwidth remains relatively small.

The expression for signal-to-noise ratio for the transistor amplifier may be obtained in the following manner. The noise figure in accordance with the definition is

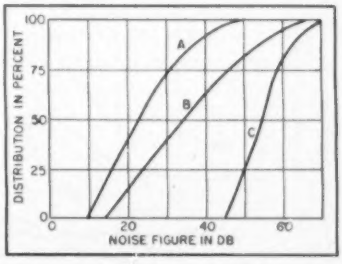

FIG. 4—Distribution of noise figure for 60 transistors of both types: *A*, junction transistors with $V_c = 1$ v and $I_c = 0.5$ ma; *B*, junction transistors at $V_c = 5$ v and $I_c = 1$ ma and *C*, point-contact transistors at $V_c = 10$ v and $I_c = 0.5$ ma

$$F = \frac{\text{noise power at output}}{\text{available noise power at input due to } R_g} \times \frac{1}{\text{transducer gain}} \qquad (7)$$

and the noise power at input will be

$$N = FKT \times (f_2 - f_1) \qquad (8)$$

Consequently, the signal-to-noise ratio

$$\frac{S}{N} = \frac{V_g^2}{4KT\,(f_2 - f_1)\,R_g\,F} \qquad (9)$$

or replacing F by F_o

$$\frac{S}{N} = \frac{V_g^2}{4\,R_g KT\,(F_o\,1{,}000 \ln f_2/f_1)} \qquad (10)$$

From Eq. 10 it can be seen, that the quantity

$$[1{,}000\ KTF_o \ln f_2/f_1]$$

is equivalent to the available noise power at input. Let us call this power equivalent noise power P_o

$$P_o \leqq 1{,}000 KTF_o \ln f_2/f_1 \qquad (11)$$

If the base of the logarithm is now changed to 10 and values of K and T substituted, the equivalent noise power will be

$$P_o \leqq 0.9 \times 10^{-17} F_o \times \log f_2/f_1 \text{ (watts)} \qquad (12)$$

This equation shows that the noise power depends on the ratio of the frequencies f_2 and f_1 and not on their magnitudes.

Equation 12 for the equivalent noise power may be rewritten approximately as

$$P_o \leqq 0.9 \times 10^{-17} F_o \times \log_2\left(1\tfrac{1}{2} + \frac{\Delta f}{f}\right) \text{ (watts)} \qquad (13)$$

where Δf is the bandwidth and f the center frequency. This equation shows that for a constant bandwidth the noise power will decrease as the center frequency increases.

The signal-to-noise ratio may now be expressed as

$$\frac{S}{N} = \frac{V_g^2}{4\,R_g P_o} = \frac{V_g^2}{3.6 \times 10^{-17}\,R_g F_o \log f_2/f_1} \qquad (14)$$

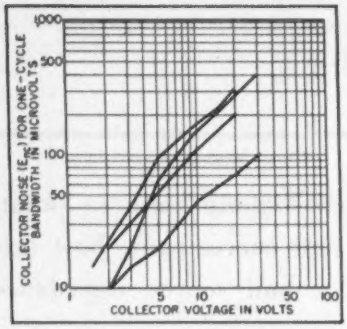

FIG. 5—Open-circuit collector noise voltage for four different point-contact transistors

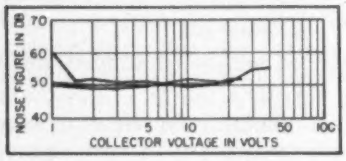

FIG. 6—Variation of noise figure with collector voltage for three different point-contact transistors

where V_g is the rms value of the signal voltage. Using this equation it is possible to determine the maximum permissible noise figure of a transistor for the first stage of an amplifier.

This is illustrated in Fig. 9 which is a plot of the Eq. 12 for different values of F_o.

Assuming that the available signal power is 10^{-9} watts in an audio band from 50 to 5,000 cps ($f_2/f_1 = 100$) and that the desirable signal-to-noise ratio must be not less than 40 db, P_o must be less than 10^{-13} watts. For the given ratio $f_2/f_1 = 100$. This corresponds to a maximum permissible noise figure of 48 db.

Similarly, in the case of an i-f amplifier with $f_2/f_1 = 1.1$, S/N = 50 db and with an available signal power of 10^{-11} watts, the maximum permissible noise figure will be 24 db.

For d-c amplifiers, if one assumes that the bandwith of the amplifier is limited by the frequencies $f_1 = 1/$ day and $f_2 = 10$ kc, and that available signal power is 10^{-10} watts, the maximum permissible noise figure of a transistor is equal to 21 db for the signal-to-noise ratio 40 db.

Amplifier Source Resistance

Equations 1, 2 and 3 give the noise figure for the three basic types of amplifier circuits. For a given operating point and given transistor, E_{ns} and E_{no} are constant. A parameter

$$\rho = \frac{E_{ns}}{E_{no}} \tag{15}$$

may be introduced, practical values for which are between 10^{-3} and 10^{-6}.

The equations for the noise figures are then: For grounded emitter

$$F = 1 + \frac{R_n}{R_g} \times \frac{\rho^2 (R_g + \alpha r_c)^2 + (R_g + r_e + r_b)^2}{\alpha^2 r_c^2} \tag{16}$$

For grounded base

$$F = 1 + \frac{R_n [\rho^2 \alpha^2 r_c^2 + (R_g + r_e + r_b)^2]}{R_g \alpha^2 r_c^2} \tag{17}$$

For grounded collector

$$F = 1 + \frac{R_n [\rho^2 (R_g + r_c)^2 + (R_g + r_b)^2]}{R_g r_c^2} \tag{18}$$

where

$$R_n = \frac{E_{nc}^2}{4\ KT\ (f_2 - f_1)} \tag{19}$$

The only parameter of these equations that can be varied externally is the source resistance R_s. Figure 10 shows the variation of F with R_g for different values of the parameter ρ.

The noise figure F has a minimum for the following values of R_g:

For grounded emitter

$$R_g' \leqq \left[\frac{\rho^2 \alpha^2 r_c^2 + (r_e + r_b)^2}{1 + \rho^2}\right]^{1/2} \tag{20}$$

For grounded base

$$R_g' \leqq [\rho^2 \alpha^2 r_c^2 + (r_e + r_b)^2]^{1/2} \tag{21}$$

For grounded collector

$$R_g' \leqq \left[\frac{\rho^2 r_c^2 + r_b^2}{1 + \rho^2}\right]^{1/2} \tag{22}$$

This minimum, however, is not very critical as it can be seen from the theoretical curves in Fig. 10 and the experimental curves in Fig. 11. Somewhat larger or smaller values of R_g may be used without an appreciable increase in amplifier noise.

Using Eq. 17 and 21 for the grounded-base connection, the minimum noise figure will be

$$F_{min} = R_n \left[\frac{2 (r_e + r_b)}{\alpha^2 r_c^2} + \frac{2\ \rho^2}{\sqrt{\rho^2 \alpha^2 r_c^2 + (r_e + r_b)^2}}\right] \tag{23}$$

Now if the value of R_g is increased or decreased four times, the noise

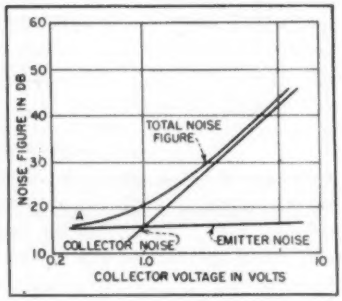

FIG. 8—Contribution to noise figure due to emitter and collector noise

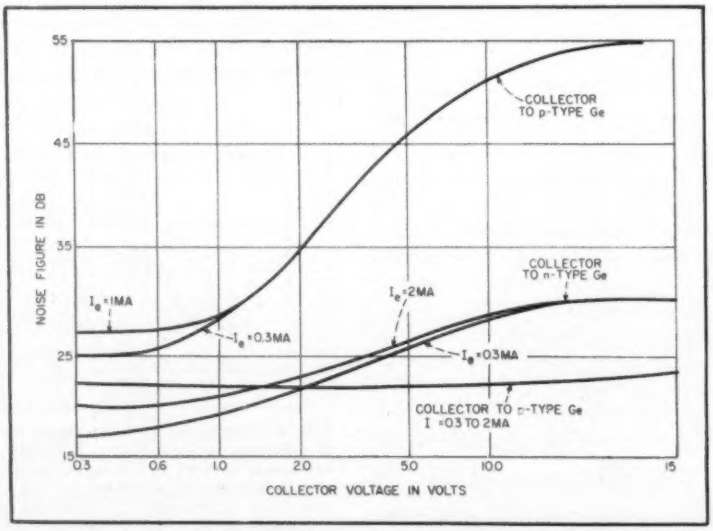

FIG. 7—Transistor noise versus operating point

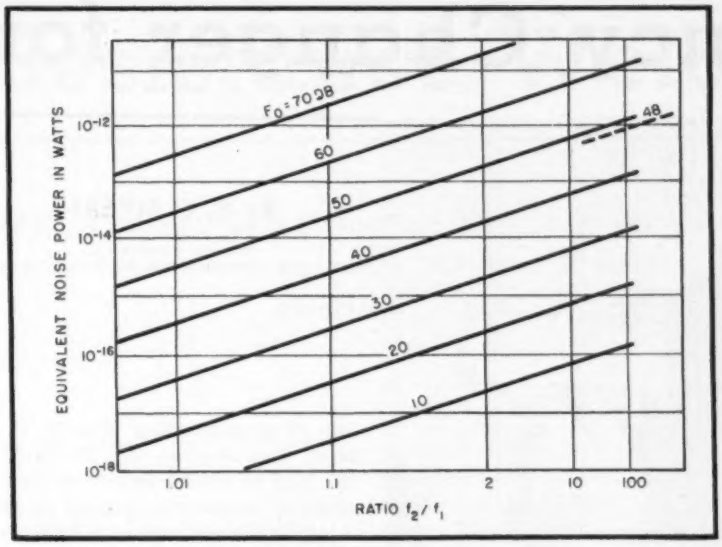

FIG. 9—Available equivalent noise power

figure will be

$$F_{min}' = R_n \left[\frac{2\,(r_e + r_b)}{\alpha^2 r_e^2} + \frac{17\,\rho^2}{4\sqrt{\rho^2\alpha^2 r_e^2 + (r_e + r_b)^2}} \right] \quad (24)$$

which indicates that the noise figure changes at most 2.12 times or 3.2 db. This figure is actually much less for most practical cases.

The addition of a resistance in series with R_g or in parallel with the input of the transistor amplifier will not improve the signal-to-noise ratio.

Generally, in multistage transistor amplifiers, the first stage will contribute significantly to the noise figure. However, if the equivalent source impedance of the second stage differs very much from the value of R_g given by Eq. 20, 21 and 22 the noise of the second stage must also be taken into account.

The noise figure of a two stage amplifier is

$$F = F_1 + \frac{F_2 - 1}{G_1} \quad (25)$$

where F_1 and F_2 are the noise figures of the first and second stage respectively and G_1 is the available power gain of the first stage. This available power gain has the following values: For grounded base

$$G_1 = \frac{\alpha^2 r_c R_g}{(r_e + r_b + R_g)\,[r_e + r_b\,(1 - \alpha) + R_g]} \quad (26)$$

For grounded emitter

$$G_1 = \frac{\alpha^2 r_c R_g}{(r_e + r_b + R_g)} \times \frac{1}{[r_e + r_b\,(1 - \alpha) + R_g\,(1 - \alpha)]} \quad (27)$$

For grounded collector

$$G_1 = \frac{r_c R_g}{(r_c + r_b + R_g)} \times \frac{1}{[r_e + r_b\,(1 - \alpha) + R_g\,(1 - \alpha)]} \quad (28)$$

The noise figure of the second stage depends on the operating point of the second transistor and the first stage output resistance. This output resistance can be changed by transformer coupling the two stages. This coupling will leave G_1 unchanged. Adjusting the transformer turns ratio so that the apparent source impedance of the second stage is that given in Eq. 20, 21 and 22, will reduce the influence of the second stage.

If the two stages are coupled without a transformer, one obtains

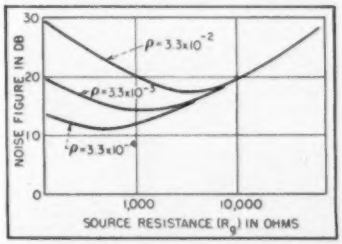

FIG. 10—Variation of noise figure with source resistance for different values of E_{ns}/E_{nc}

the following approximate expressions for the grounded emitter stage: Assuming that in Eq. 1; $E_{nc}^2 >> E_{ns}^2$ and $R_g = R_{o1}$ (where R_{o1} is the output resistance of the first stage of the amplifier) and $R_{o1} >> R_e + R_b$, the noise figure of the second stage is

$$(F_2 - 1) \leqq \frac{E_{nc2}^2}{4\,KTB} \times \frac{R_{o1}}{\alpha_2^2 r_{c2}^2} \quad (29)$$

The available power gain is

$$G_1' = \frac{\alpha_1^2 r_{c1}^2 R_g}{(r_{e1} + r_{b1} + R_g)} \times \frac{1}{[r_{e1} + r_{b1}\,(1 - \alpha_1) + R_g\,(1 - \alpha_1)]} \quad (30)$$

First stage output resistance is

$$R_{o1} = r_{c1} \times \left[\frac{r_{e1} + r_{b1}\,(1 - \alpha_1) + R_g\,(1 - \alpha_1)}{r_{e1} + r_{b1} + R_g} \right] \quad (31)$$

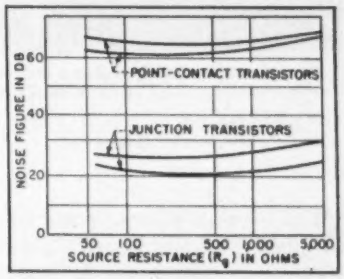

FIG. 11—Comparison of noise figure in point-contact and junction transistors

and therefore

$$F = F_1 + \frac{E_{nc2}^2}{4\,KTB} \times \frac{[r_{e1} + r_{b1}\,(1 - \alpha_1) + R_g\,(1 - \alpha_1)]^2}{\alpha_2^2 r_{c2}^2 \alpha_1^2 R_g} \quad (32)$$

This equation permits calculation of the contribution of second stage to overall noise figure for direct or R-C coupled amplifiers.

Noise in transistor amplifiers is similar to contact noise insofar as it depends strongly on the frequency. Total noise power is not proportional to amplifier bandwidth but depends on the ratio of the frequencies limiting it.

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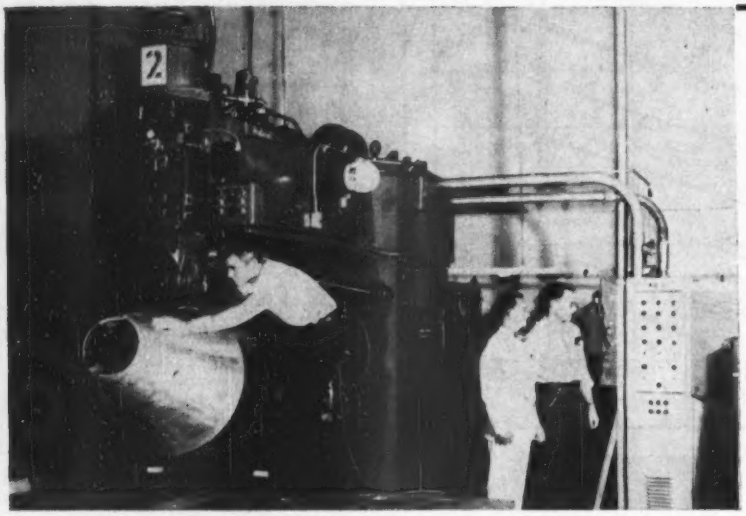
Frequency Changer for



Three-phase resistance welding control (right) used with a spot-welding machine at a West Coast aeronautical plant

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THREE-PHASE POWER of one frequency, usually 60 cycles, may be changed electronically to single-phase power of lower frequency. This practice eliminates the annoying blinking of lights caused by the large intermittent load of a resistance welder on an inadequate power supply. Quality of welds is improved by elimination of these voltage dips when several welding machines are operated randomly on the same lines.

One cause of the heavy load is that resistance-welder loads usually are highly inductive and have a low power factor at 60 cycles. The welding transformer secondary circuit of a large press-type welder is essentially a very-low-resistance loop. In some cases, the welding current is largely reactance limited and only part of the kva demand is used for heating.

Changing to a lower frequency decreases the reactance drop, improves the power factor, reduces the required secondary voltage and reduces the kva demand and line drop. Distributing the demand current on three lines, instead of on two lines, further reduces the line drop.

The frequency-changing principle is shown in Fig. 1. A cycle of the l-f single-phase output is started with a l-f half cycle, arbitrarily called a positive half cycle. This l-f half cycle is started by drawing power through a power tube, from what is designated as the *A* phase of the three-phase power supply (lines 1 and 2). Instead of allowing this phase to continue to energize the load at 60 cycles, the load is transferred to phase *B* by means of power tubes when the phase-*B* voltage of corresponding polarity exceeds that of phase *A*. Similarly, the load is next transferred from phase *B* to phase *C*, then to phase *A* and so on to produce a continuous load voltage of positive polarity for the first half cycle of the low frequency.

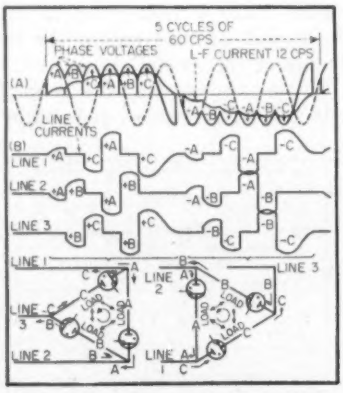


FIG. 1—Basic principle of converting three-phase power to single-phase low-frequency power by using power tubes

Load voltage is made up of 120-deg segments of positive voltages from the three phases. Load current is composed of 120-deg blocks of unidirectional currents drawn successively from the three phases as shown in Fig. 1A. The power lines carry alternating current as shown in Fig. 1B. The distinct build-up of the load current as shown by the waveform sketch is for an inductive load (welder load) and is a characteristic of the current rise when d-c is applied to an inductive circuit.

During the l-f half cycle, the load transformer must be capable of developing a continuously increasing flux to generate the required unidirectional back emf or induced voltage. After a few cycles of applied rectified 60-cycle three-phase voltage, the load is disconnected from the power supply. At the end of the positive l-f half cycle, and when the phase-*A* voltage reverses, the load is reconnected to phase *A* through a power tube of opposite polarity so as to cause the load transformer to induce a secondary voltage of negative polarity to start the negative l-f half cycle.

Load Transfer

By means of power tubes, the load is transferred from phase to phase at the proper instant to provide a continuous load voltage of negative polarity to make up the

Resistance Welding

Direct conversion from three-phase 60-cycle power to single-phase low-frequency power improves power factor and reduces kva demand and line drop compared to the more commonly used 60-cycle single-phase machines

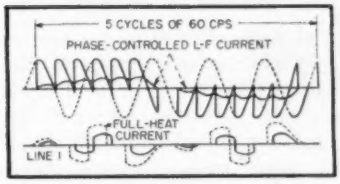


FIG. 2—Phase-controlled power tubes determine the effective value of the single-phase low-frequency voltage

negative l-f half cycle during a few cycles of the 60-cycle supply.

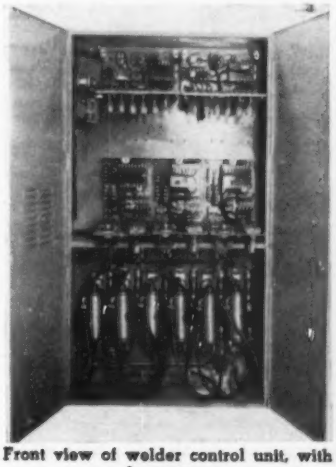
Each l-f half cycle is started by drawing power from phase *A* and is terminated by drawing power from phase *C*. In the case illustrated by Fig. 1, power is fed to the load during two cycles of the 60 cycles, with one-half of a 60-cycle between l-f half cycles. The whole l-f cycle has a duration of 5 cycles out of 60 cycles or a fundamental frequency of 12 cycles.

Heat Control

Power tubes, used for transferring the load from phase to phase as previously explained, also provide a convenient means of adjusting the effective value of the applied l-f voltage. This heat control is effected by delaying the transfer from one phase to the next as shown by Fig. 2.

The transfer is shown in Fig. 1 as occurring at about 30 deg on the phase voltages, thus utilizing the maximum envelope of the three phase voltages. In Fig. 2, the transfer is shown as occurring at about 65 deg on the phase voltages and producing about 50-percent maximum current or 25-percent heat. The range of current control from 100 down to 20 percent (100 to 4-percent heat) requires adjusting the transfer or commutation from about 30 deg to 110 deg on the phase voltages. Figure 2 also shows the current in line 1 which is composed of the currents of the *A* and *C* phases. For reference, the full-heat current is shown dotted.

Figure 3A shows a case where the duration of applied unidirectional voltage during the l-f half cycles, designated as the pulse time, is increased to 3 cycles of the 60 cycles for a welding frequency of 8-4/7 cps. With other factors the same, the welding transformer must be capable of developing a larger amount of flux for 3 cycles than for 2 cycles because it must maintain the same rate of increase in flux for the longer time interval of a l-f half cycle. Size of the welding transformer is determined by the pulse time. For example, Fig. 3B also has a welding frequency of 8-4/7 cps, but has a pulse time of 2 cycles and can use a smaller welding transformer.



Front view of welder control unit, with doors open

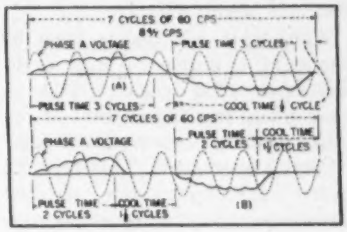


FIG. 3—Illustration of terms pulse time and interpulse time

Figures 1, 2 and 3 show l-f welding current as applied to produce a spot weld requiring one or more l-f cycles of current. The reasons for using different pulse times as shown by Fig. 1A and 3A, or for using different time intervals (designated as interpulse time) between l-f half cycles as shown by Fig. 1A and 3B, are somewhat as follows:

Benefits from reduction in kva demand are greater when using lower welding frequency as in Fig. 3A but the lower transformer frequency requires a larger welding transformer. In general, the optimum low frequency is considered as being 8-4/7 or 12 cps, with a pulse time of 2 or 3 cycles.

There are several uses for different time intervals between the l-f half cycles as shown by Fig. 1A and 3B. Thin gauges of metal may be welded by using a single l-f half cycle. In some cases, seam welding may be done by the continuous application of l-f half cycles and by using a time interval of a few cycles of 60 cps between l-f half cycles. Thus, the interpulse time interval between l-f half cycles in Fig. 1A, 3A and 3B is much longer

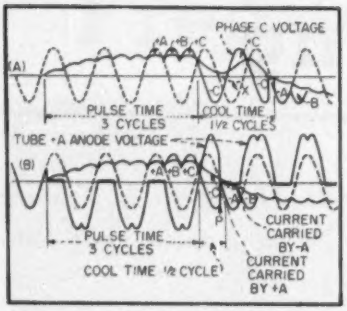


FIG. 4—Cause of commutation faults (A) and prevention of commutation faults by applying inversion operation (B)

than for seam welding.

When spot welding is done by means of a single l-f half cycle, successive spot welds should be made using welding current of opposite polarity, known as antipolar half-cycle operation. This practice avoids energizing the welding transformer with a series of unidirectional voltage impulses which might cause saturation of the welding transformer. If unidirectional l-f half cycles are used for spot welding, the welding transformer should be premagnetized with flux of opposite polarity during the intervals between welding.

Commutation Faults

Certain conditions of spot welding with full l-f cycles may require using more than ½-cycle interpulse time, as shown in Fig. 4A. A long pulse time, a high percentage current setting and a secondary circuit having high inductance may, at the end of a l-f half cycle, cause the current from the *C* phase to drag out. These conditions would keep the load connected to phase *C* until phase *C* again becomes positive.

Starting the negative l-f half cycle at point *X* while the positive current persists will result in a commutation fault. The supply currents, being limited only by resistance of transformer primary windings and leakage reactance between windings, would be excessive and several times their normal magnitude. The commutation fault may be prevented by increasing the interpulse time interval between l-f half cycles as shown in Fig. 4A. Another method of avoiding commutation faults, which provides a more continuous flow of welding current, is the use of inversion as shown in Fig. 4B.

Inversion

Inversion operation consists of controlling the conductivity of the power tubes so that at the end of a l-f half cycle, the energy stored in the load and welding transformer continues to be forced back into the supply to extinguish the current. Otherwise, the load and welding transformer would again draw power from the *C* phase. As shown in Fig. 4B, inversion operation is accomplished by transferring the phase-*C* drag-out current (at point *P*) to the phase-*A* power tube which has been operating during the l-f half cycle. A voltage of opposite polarity to the preceding l-f half cycle is maintained on the primary of the welding transformer to accelerate the decay of primary current.

At point *P* in Fig. 4B, the phase-*A* voltage is zero and the phase-*A* power tube cannot be fired on the phase-*A* voltage. If phase *C* is still connected to the load by drag-out current through the *C* power tube, the phase-*C* voltage is induced in the anode circuit of the *A* power tubes. During that part of the cycle, the anode voltage of the phase-*A* power tubes is the difference between the phase-*A* and phase-*C* voltages. Because of the induced transformer voltage, there is considerable positive anode voltage to refire the phase-*A* power tube at the time the phase-*A* voltage is zero.

Immediately after point *P* and during the time that the drag-out current is being carried by the +*A* power tube, the anode voltage of the −*A* power tube is negative. The grid of its firing tube may be turned on so that the next l-f half cycle starts as soon as current of the preceding half cycle is extinguished. In contrast with the case of Fig. 4A where a welding frequency of 8-4/7 cps is desired but a welding frequency of 6.67 cps must be used to prevent a commutation fault, the addition of inversion operation as shown in Fig. 4B permits using the 8-4/7-cps frequency with a more steady flow of welding current.

Control Operation

The mode of l-f control operation is outlined by the schematic diagram of Fig. 5. All control tubes are small thyratrons. Larger thyratrons are used for firing the ignitron power tubes. Control is a-c operated in that all tubes have a-c anode voltages. This frequency-changing control may be separated into five functional sections: the sequence control, low-frequency timer, trailing exciters, firing tubes and power tubes (with the welding transformer). The control functions of each of these sections and the relationship of section operations will be explained with reference to Fig. 5.

As shown by Fig. 5, the sequence control and low-frequency timer operate from phase-*A* control voltage. Governed by the sequence control, the squeeze time allows the welder electrodes to close on the work before welding current is applied. The weld interval is the duration of low-frequency welding current. The hold time maintains the electrode pressure on the work while the weld is cooling. The off

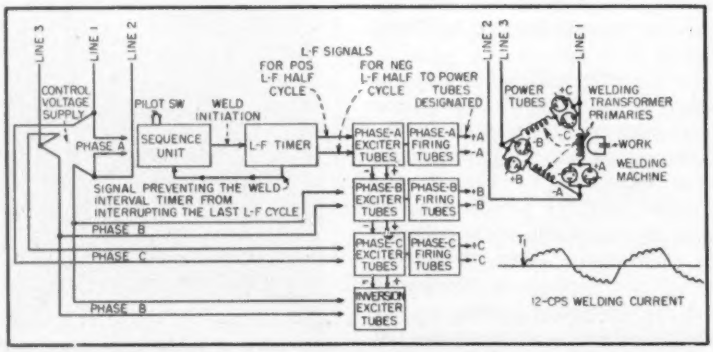


FIG. 5—Control and power circuit sections and basic mode of operation

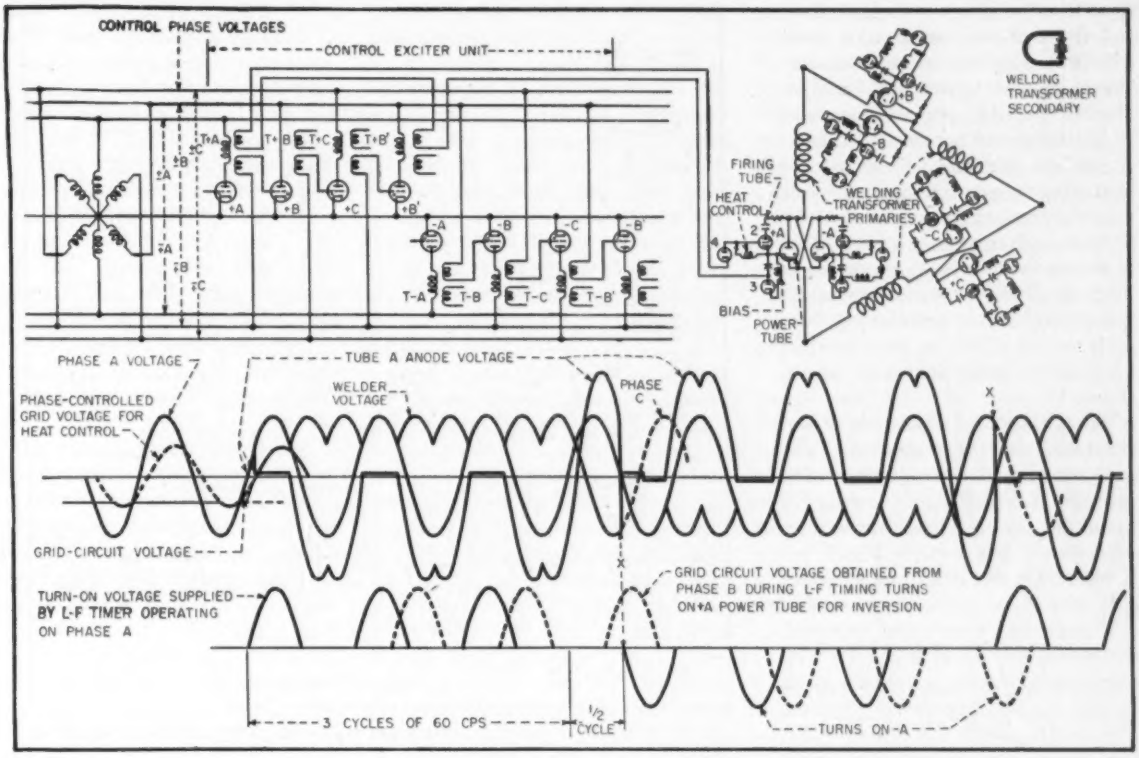


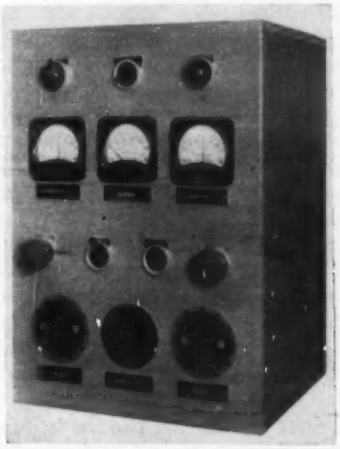
FIG. 6—Details of exciter unit circuit and power circuit, including firing tubes

time, used only for repeat operation, is the time that the electrodes remain open for the removal of the welded parts and the placement of new parts to be welded.

The l-f timer controls the duration of the l-f half cycles (pulse time) and the time interval between l-f half cycles (interpulse time). It also insures that each weld starts with a full positive l-f half cycle and is ended with a full negative l-f half cycle to provide complete l-f cycles of welding current, except where l-f half-cycle welding is being done.

In response to the l-f timer, the exciter section sets up a pattern of three-phase control voltages or signals for turning on the firing tubes in the proper order. The control operation thus branches out into three-phase operation in the exciter section. Inversion control also originates in this section. The $+A$ exciter tube controls all the other tubes in the + circuit branches (phases A, B, C) extending toward the power circuit. The $-A$ exciter tube controls all the other tubes in the — circuit branches extending toward the power circuit.

The turn-on voltages from the exciter unit, applied in the grid circuits of the firing tubes, are really releasing voltages rather than turning-on voltages because the operation of the firing tubes further depends upon phase-controlled voltages in their grid circuits for heat control (percent current). The firing tubes turn on the ignitron power tubes to phase-control the three-phase power applied to the welder and to refire the *A* power tubes at the right time for inversion operation.



Operator's control station, showing control operation adjustments

In this case, the load consists of the welding transformer having three primary windings and one secondary winding on a common magnetic core. It may be considered as a single-phase welding transformer having three primaries connected to the three-phase power supply through time-controlled and phase-controlled power tubes to compose the single-phase l-f output.

Circuit Details

The power circuit, including the welding transformer, power tubes and firing tubes, is shown in the upper right corner of Fig. 6. Igniter current of each power tube is controlled by the firing tube connected between anode and igniter. Since each power tube and its firing tube have the same anode voltage, except at the instant while the igniter current flows, the combination may be thought of as grid control on the ignitron.

During standby, the anode volt-

ages are the phase voltages. During three-phase operation, a much different condition exists. Consider the *A* power tubes, for example. During welding, the anode voltage is the difference between the phase-*A* voltage and the voltage of the operating phase induced through transformer action in the primaries of the welding transformer. This is shown in the waveform sketch of Fig. 6. This condition must be recognized when considering tube ratings and should be kept in mind when considering inversion operation.

All of the firing tubes are phase-controlled for heat control. The grid circuits of the *A* firing tubes provide the additional feature of inversion. An *A* firing tube and its grid circuit is shown in Fig. 7 for the analysis of firing-tube grid-circuit operation.

Figure 7A shows the essential components of the grid circuit. The component circuits are shown separately in the successive figures. Figure 7B shows the negative d-c grid-bias voltage provided by rectifier 3 and applied by switching tube 4 to keep the firing tube nonconductive during standby. Figure 7C shows the phase-shifted sine-wave component of voltage applied to the grid to trigger the firing tube at the desired point in the anode voltage wave. These component voltages of the grid circuit exist simultaneously during standby and are shown combined in Fig. 7D. In this case, during any time in the cycle the grid potential of the firing tube is at which ever potential is more negative, the d-c bias or the sine-wave phase-controlled voltage component.

In Fig. 7E, a half cycle of sine-wave turn-on (or releasing) grid voltage in phase with the firing-tube anode voltage is applied to raise the cathode potential of switching tube 4 above the cathode potential of the firing tube. The firing tube is then permitted to become conductive in accordance with the phase-controlled grid voltage or heat setting.

In Fig. 7F, the turn-on grid voltage is obtained from phase-*B* control voltage and the firing tube is not triggered until the phase-*A* voltage has decreased to about zero

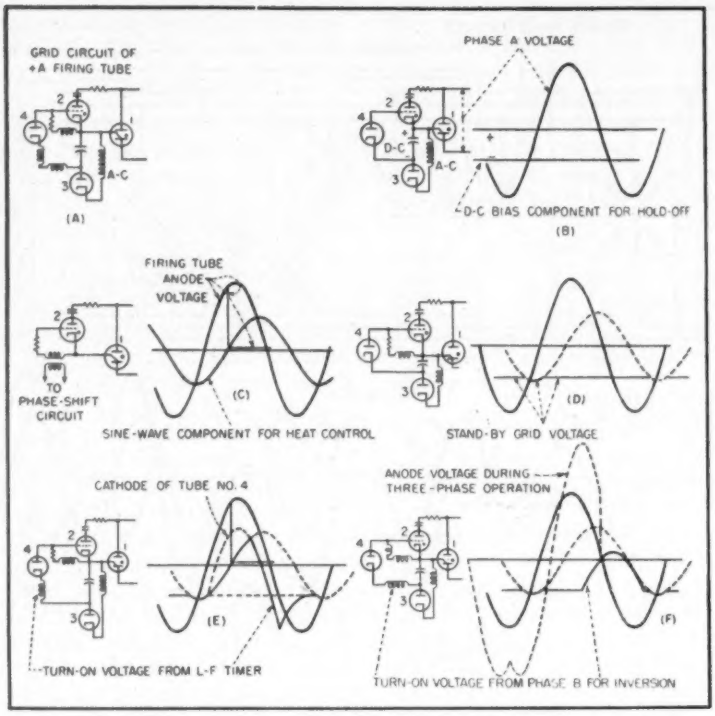


FIG. 7—Analysis of firing-tube grid circuit for turn-on, heat control and inversion

at the end of the positive half cycle of anode voltage. However, at this time there is considerable anode voltage as previously explained. At the end of a l-f half cycle, if *A* firing tube has not been triggered for heat control and if the phase-*C* power tube continues to carry current, the *A* power tube is fired to provide inversion operation.

Exciter Unit

With reference again to Fig. 6, the exciter tubes turn on and control the order of firing of the firing tubes. The $+A$ and $-A$ exciter tubes respond in accordance with the l-f grid-supply voltage patterns made up by the l-f timer. The $+A$ exciter tube, with its trailing $+B$ and $+C$ tubes, turn on the positive half cycle of l-f welding current. The $+B'$ exciter tube, trailing the $+C$ exciter tube, provides the half cycle of voltage from phase *B* to turn on the $+A$ firing tube for inversion operation at the end of the positive l-f half cycle. The $-A$, $-B$, $-C$ and $-B'$ exciter tubes operate in similar manner to produce the negative l-f half cycle of welding current.

The l-f timer is composed of electronically interlocked electronic timing circuits. Operation of the l-f timer may be explained best by first considering Fig. 8. This circuit embodies all of the basic circuit operating principles in the l-f timer.

With reference to Fig. 8A, the anode voltage of thyratron tubes 1 and 3 are in phase but are 180 deg out of phase with the anode voltage of thyratron tube 2. Each tube has an a-c sine-wave grid bias, 180-deg out of phase with its anode voltage and supplemented by the conventional d-c self-rectified bias. When the initiating switch is closed, tube 1 will conduct during the next positive half cycle of its anode voltage as shown by E_1 of Fig. 8B. The anode circuit is inductive and tube 1 will continue to conduct for a portion of a half cycle after the anode supply voltage has reversed and become negative. During this time, after the anode supply voltage has reversed, the anode of tube 1 is maintained positive by the inductive anode current feeding back into the control voltage supply.

During the carry-over of tube 1, the grid of tube 2, connected to the anode of tube 1, is held positive and

tube 2 trails as shown by E_2. Tube 2 may start conducting as soon as its anode voltage becomes positive. It does not have to wait until tube 1 stops. Similarly, tube 1 will now trail tube 2 if the initiating switch is opened. The operation of tubes 1 and 2 may be initiated by closing the initiating switch but cannot be stopped by opening the switch.

If the self-rectified bias component of the grid voltage applied to tube 3 has a very short time constant, tube 3 will trail tube 2 immediately. As shown, the self-rectified bias of tube 3 is adjustable (C_t and R_t) and, for the case of the waveform sketch, is set to provide a grid voltage as shown by the curve designated E_t, timing grid voltage. During the next positive half cycle of anode voltage on tube 3 after tube 2 starts conducting, the grid of tube 3 is held negative by the negative d-c timing voltage and tube 3 does not trail tube 2 immediately. After a time delay, shown as set for one cycle, the timing voltage decays sufficiently to allow the grid of tube 3 to become positive at point P and tube 3 conducts during the next positive half cycle of anode voltage. The time constant of the timing circuit may be adjusted so that tube 3 will not start conducting until several cycles after tube 2 starts conducting.

Tube 3 has a neutralizing transformer in its anode circuit. This transformer is equivalent to a reactor having a secondary winding. Transformer T_s secondary voltages are shown by the curve designated E_{3TS}. One secondary of transformer T_s feeds an impulse of this voltage back into the grid circuit of tube 2 to neutralize the positive grid-voltage component derived from the carry-over of tube 1. Tube 2 cannot trail tube 1 during the next half cycle after tube 3 conducts.

If the initiating switch has previously been opened, the nonconduction of tube 2 will cause tubes 1 and 3 to stop and the circuit comes to rest. If the initiating switch has been maintained closed, tube 1 will continue to conduct and the nonconduction of tube 2 will stop only tube 3. During the half cycle that tube 2 does not conduct, timing capacitor C_t recharges by grid current from tube 3. During the next half cycle, tube 3 does not conduct. Then tube 2 starts conducting again and thus reinitiates the operation. Tube 3 operates periodically during every third cycle of its positive anode voltage. The R-C circuit may be adjusted for several cycles between conductions.

The circuit may be extended so that the anode potential of tube 3 triggers periodically other tubes connected similarly, or a secondary of transformer T_s may be used to initiate or cause certain control functions to be performed in other circuits. Other patterns of signal voltage may be supplied by providing transformers in the anode circuits of tubes 1 and 2. By the use of these circuit operating principles, almost any kind of sequencing or timing-voltage pattern based on 60-cycle control operation can be provided. This will be evident during the explanation of the l-f timer operation.

It should be observed that this circuit operation is synchronous. That is, the initiating tube 2 and timing tube 3 must start conducting at the beginning of their positive half cycles of anode voltage or they cannot conduct at all. This is because the grid voltage abruptly goes negative soon after the anode voltage becomes positive.

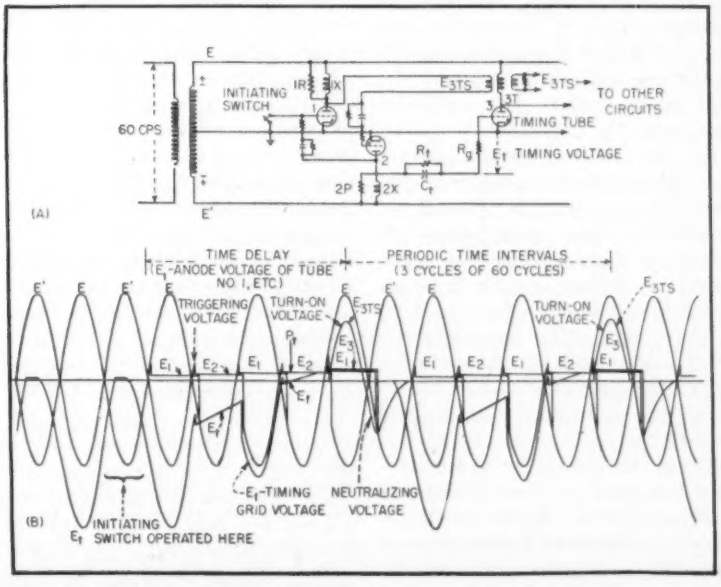


FIG. 9—Basic timing circuit used in low-frequency timing section

Low-Frequency Timer

Figure 9A shows the circuits of the l-f timer, including sequence control tubes 4 and 5 that are directly associated with l-f operation. Figure 9B shows the time relationship of the control-tube operations. This is an 8-4/7 cycle welding frequency having 3-cycle pulse time and one-half cycle cool time.

With reference to Fig. 9A and 9B, the l-f circuit operation is as follows: At the end of the sequence squeeze time, when the welder electrodes have closed on the work, tubes 4 and 5 operate simultaneously. Tube 5 initiates the weld interval. Tube 4 initiates the positive l-f half cycle of welding current by triggering the $+A$ exciter tube and initiates l-f timing by triggering tube 11. Tube 4 also prevents weld-interval timer-tube 6 from trailing tube 5 in case the weld-interval R-C timing circuit times out during the l-f cycle.

Because of the inherent ½-cycle delay of one tube trailing another, there is one-cycle inherent delay between tubes 4 and 12. For an 8-4/7 cycle welding frequency having 3 cycles of 60-cps pulse time, three times around on the three phases, the inherent one-cycle delay between tubes 4 and 12 is supplemented with a two-cycle R-C delay designated as pulse time No. 1. This allows the $+A$ exciter tube to

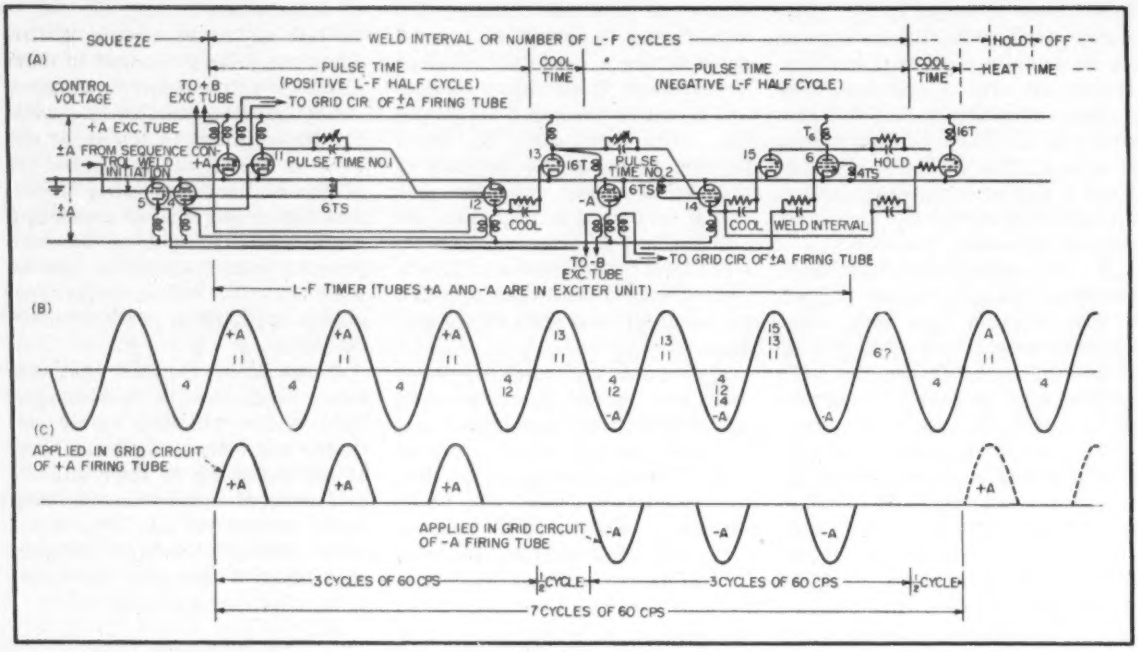


FIG. 9—Low-frequency timing circuit

operate three times in succession, as shown by the waveform sketch Fig. 9C. Tube 12 then conducts and stops the $+A$ exciter tube from trailing tube 4. This operation, including inversion operation which originates in the exciter unit, terminates the positive l-f half cycle of welding current.

For minimum permissible interpulse time of ½ cycle (60 cps) between l-f half cycles, there must be one full 60-cps interval between conductions of the $+A$ and $-A$ exciter tubes. The $-A$ exciter tube must be turned on for the pulse time of 3 cycles of 60 cps. The voltage patterns for three successive conductions of the $+A$ exciter tube and three successive conductions of the $-A$ exciter tube must be antipolar. Tube 13 is allowed to trail tube 12 without time delay and the $-A$ exciter tube trails tube 13 to start the negative l-f half cycle of welding current.

A one-cycle R-C delay between tubes 13 and 14 allows the $-A$ exciter tube to conduct once before tube 14 conducts, and this exciter tube trails tube 13 a second time while tube 14 conducts. Tube 15 trails tube 14 without time delay. Tube 15, by energizing transformer T_6, stops tubes 4, 12 and 14 from trailing their respective leading tubes but the $-A$ exciter tube trails tube 13 for the third time (three times around on three-phase operation).

Tubes 11, 13 and 15 that were trailing tubes 4, 12 and 14 are stopped. None of these tubes conduct during the next cycle (of 60 cps) after tube 15 operates. The weld-interval initiating tube 5 in the sequence control continues to operate. Tube 4, stopped by tube 15, gives tube 6 a chance to operate if the weld-interval R-C timing circuit has timed out. This completes one cycle of l-f operation.

If the weld interval has not elapsed to limit the l-f welding current to one l-f cycle, tube 6 will not conduct to keep transformer T_6 energized after it has been energized for one-half cycle by tube 15. Since tube 6 does not respond, tube 4 starts conducting again and reinitiates the next l-f cycle of welding current and tube 4 again blocks tube 6 from operating during the next l-f cycle.

When the weld-interval R-C circuit does time out, tube 4 holds off the operation of tube 6 until the l-f cycle is completed. When the weld interval has elapsed during the l-f cycle and when tube 15 stops tube 4 at the end of the l-f cycle, weld-interval timer-tube 6 is released to keep T_6 energized. The anode of tube 6, which is connected to the anode of tube 15, prevents tube 4 from reinitiating any more l-f cycles of welding current. Therefore the welding transformer is energized for full l-f cycles. Tube 16 is required to terminate the negative l-f half cycle when the interpulse time exceeds 1½ cycles.

Tube 6 also initiates the hold-time during which the welder electrodes remain closed with full pressure on the work while the weld is cooling. From the foregoing description of the l-f timing circuit operations, one may visualize the general scheme of providing the sequence control functions of squeeze, weld interval, hold and off periods by means of a group of similar interlocked component timing circuits.

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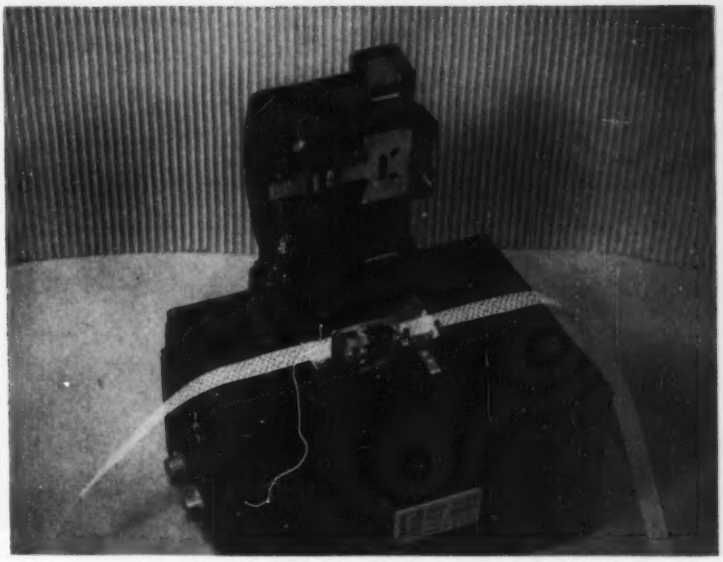


Tape reader, with lamp housing lifted to show feed mechanism

Intermittent-Feed Computer Tape Reader

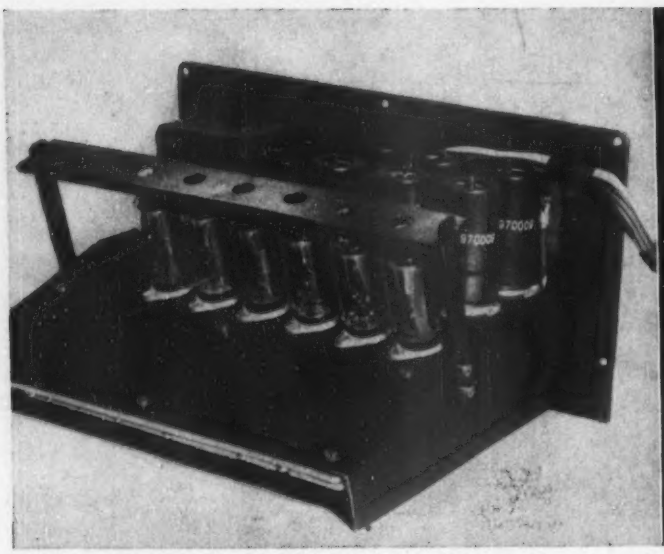
Five-phototube input system for digital computers reads teleprinter punched tape at speeds up to 200 five-hole characters per second. Intermittent tape drive uses clutch and brake solenoids fed by signal derived from sixth phototube located under tape sprocket holes

WHILE the storage and arithmetic units of a digital computer are extremely rapid in operation, a limit to the overall speed of computation is often set by the comparatively slow speed of the input-output system.

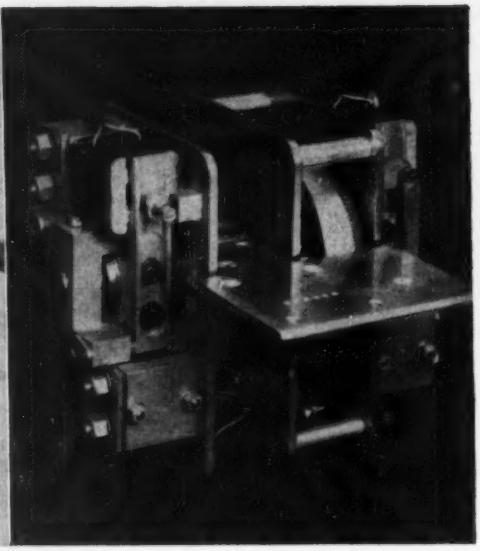
With this point in mind, the tape reader described has been developed for use in the input system of the Ferranti Digital Computer (Mark I), the first of which was installed in the University of Manchester, Manchester, England, and the second in the University of Toronto. Five-unit teleprinter tape is used and the tape reader is capable of operation at speeds up to 200 characters per second. One character is represented by a single row of holes across the tape. Provision is made for the tape to be stopped at each character and, after reading has been completed, to be moved forward to bring the next character into place.

The present tape reader adopts a friction drive arrangement in which the tape is driven by means of a drum held firmly against the tape by a pair of spring-loaded rollers. Wear on the tape through the use of such a drive is negligible. A tape which becomes twisted or is otherwise prevented from passing through the tape reader in a normal manner is able to slip in the mechanism without being torn. A loop of tape has been passed through the tape reader 10,000 times without signs of wear. Splicing of the tape is not a critical operation. A photoelectric reading system has been adopted, which obviates the necessity for metallic contacts and uses the sprocket holes in the tape in a rapid and efficient tape-positioning arrangement.

The general arrangement of the drive mechanism is indicated in Fig. 1. A differential gear is driven by a continuously running induction motor. To one of the output shafts of the gear is attached the



Six phototubes of system are in foreground, with cathode follower stages and power transformer behind. Optical system is in main housing, not shown



Tape feed assembly; brake drum and braking solenoids are at left, and clutch drive system is at right

tape-feed drum and a drum known as the brake drum. To the second output shaft of the gear is connected another drum known as the clutch drum. With this arrangement, the sum of the velocities of the two output shafts is equal in value to twice the velocity of the input shaft. If one of the output shafts is held stationary, the other will achieve a velocity equal to twice that of the input shaft. Rotation of the tape-feed drum is controlled by electromagnetically operated brakes on the brake drum and clutch drum.

The braking mechanism is illustrated in Fig. 2. In the off position, the brake shoes are held lightly against the drum and only a slight movement of the armatures is required for braking. The greater part of the force produced by energizing the electromagnets is thus utilized in forcing the brake shoes against the drum. Since each armature is held close to the core of its electromagnet, a small air gap is possible, giving a high gap flux and economy in magnetizing current.

Brake Design

The air gap is of the order of 0.002 inch in the brake drum system and 0.01 inch in the clutch drum. The armatures are made of soft iron and are designed to have a rigid construction with low inertia. The core is built of Radiometal laminations. The coils have an inductance of 2½ henrys and a resistance of 80 ohms.

A pull of ¾ lb is exerted by each electromagnet on its armature and the measured braking force at each brake shoe is 1½ lb; with a coefficient of friction estimated at 0.4 this results in an effective braking force on each drum of 1.2 lb and a braking torque of 0.48 lb-in. The drums are constructed of stainless steel since a plated surface would, when worn, tend to produce a non-uniform surface. A resin-bonded fabric (Tufnol) has been used for the brake shoes and has shown no sign of wear after many months of service.

The two braking systems are controlled by a bistable triggered circuit, the state of which decides whether the brake or the clutch will be operated upon. The inertia of the moving parts has been kept as low as possible in order that rapid and efficient braking and acceleration of the tape can be obtained. The inertia of the two drums and the associated moving parts is calculated to be 0.015 lb-in.[3] Applica-

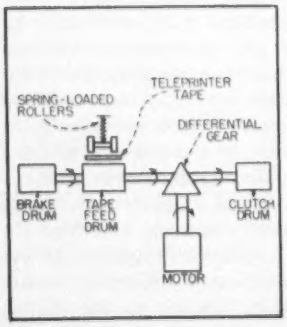


FIG. 1—Tape feed mechanism

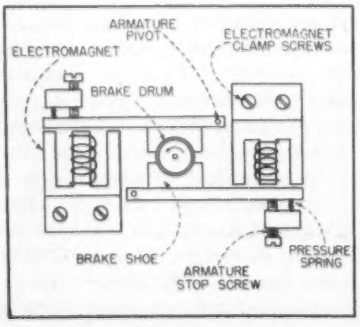


FIG. 2—Arrangement of brake

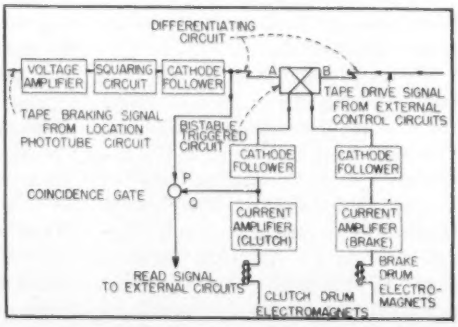


FIG. 3—Electronic control system for tape feed

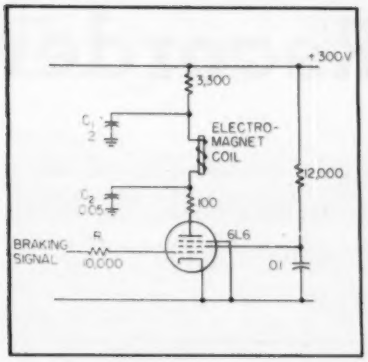


FIG. 4—Solenoid control circuit

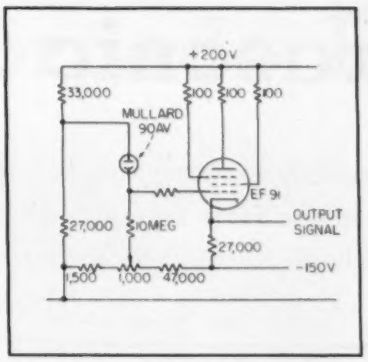


FIG. 5—Photoelectric reading stage

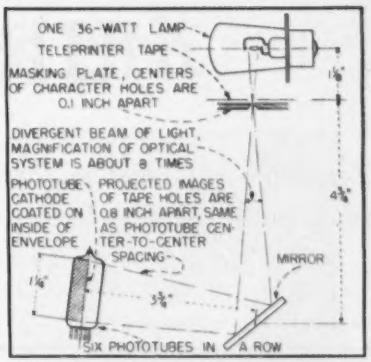

ONE 36-WATT LAMP
TELEPRINTER TAPE
MASKING PLATE, CENTERS OF CHARACTER HOLES ARE 0.1 INCH APART
DIVERGENT BEAM OF LIGHT, MAGNIFICATION OF OPTICAL SYSTEM IS ABOUT 8 TIMES
PHOTOTUBE CATHODE COATED ON INSIDE OF ENVELOPE
PROJECTED IMAGES OF TAPE HOLES ARE 0.8 INCH APART, SAME AS PHOTOTUBE CENTER-TO-CENTER SPACING
MIRROR
SIX PHOTOTUBES IN A ROW

FIG. 6—Optical system of reader

tion of braking torque stops the drum in 0.004 sec. This represents a displacement of 0.04 in. of the tape. Due to delay in operation of the electromagnet, a further 0.005 in. displacement must be taken into account. If braking is commenced when a character is just entering the reading position, the tape will be stopped while the character is located centrally in the reading position. From a stationary position, full speed may be reached and the next character made available for reading within six milliseconds.

Tape-Feed Control System

One system of tape feed which has been devised is indicated in Fig. 3. Sprocket holes in the tape are used to control the braking systems. Entry of a character into the reading position over the masking plate holes initiates a tape-locating signal which operates the brake drum system. The signal is applied to a squaring circuit and thence to a cathode follower whose output is connected to one input of the triggered circuit. By this means, the locating signal produces a trigger pulse at A which applies the appropriate output of the triggered circuit to the brake-drum electromagnet circuits.

A read signal will be given to the external circuits only when two negative-going signals are applied simultaneously to the inputs of the coincidence gate at P and Q. If for any particular character the tape does not stop in the correct position, the signal at P will no longer be present and, although the triggered circuit will be set, no read signal will be transmitted. When reading is completed, a signal is applied to B, resetting the triggered circuit and causing the clutch mechanism to operate and the tape to move forward.

It is essential that the buildup of the current in the electromagnet coils be as rapid as possible. To insure this, a large voltage must be applied initially across the coils. Referring to Fig. 4, the grid of V_1 has a large negative potential in the absence of a signal from the triggered circuit. When a braking signal is applied, the grid potential of V_1 quickly becomes zero. This action will result in a rapid fall of anode potential and, since point P is initially at plate supply potential, there is applied across the coil a sudden large change of voltage. Due to the presence of C_1, the voltage across the coil tends to be maintained and there is a consequent rapid rate of increase of current in the coil. The time taken for the current to build up to its maximum value is 0.5 millisecond. When V_1 becomes cut off again, in the absence of a signal, C_2 limits the rate of decay of current through the coil and hence limits the back emf.

Photoelectric Circuits

Six phototubes are provided in the tape reader, each being connected to a cathode follower. Five of these phototubes are associated with the positions of the five digits of a character on the tape. The sixth or reader location phototube is associated with the sprocket holes and is used to control the movement of the tape.

A typical phototube circuit is shown in Fig. 5 along with the optical system, which uses a single 36-watt prefocussed lamp. By means of the pinhole projection principle, images of the cylindrical (coiled) filament of the lamp are formed by the holes in the tape so as to cover the entire area of the appropriate phototube cathodes.

Blue-sensitive phototubes have been found most suitable for this tape reader. With tubes having a sensitivity of 45 μa per lumen, a signal change of at least 12 volts is available due to the presence of light through a hole.

The tape-reader unit comprises the tape-feed mechanism, the optical projection system and the phototube circuits together with their cathode followers. Provision is made for viewing the tape in the reading position. The tape may be left stationary in the tape reader for long periods without deterioration by heat from the lamp.

Although the tape reader was designed for a specific purpose, it should be readily adaptable for many other applications of a similar nature and in telecommunications. A model of this tape reader has been developed to accommodate either 5-unit or 7-unit teleprinter tape.

The author wishes to express his thanks to the following members of the Computer Group at Ferranti Ltd.: B. W. Pollard for his guidance and helpful suggestions, G. Fox for his help in the production design of the tape reader and D. F. Chatt for his assistance in the preparation of this article.

Ultrasonic Recorder

Torpedo-borne recorder continuously measures running depth by transit time of ultrasonic pulse reflected from ocean's surface. Lock-out bars false echoes arising from scattering. Output level holds when echoes are lost due to roll and pitch

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INSTANTANEOUS running-depth of a torpedo may be found by recording transit time of ultrasonic pulses reflected by the air-water interface at the surface of the ocean. An ultrasonic transmitter and receiver with necessary timing circuits is mounted in the exercise head of the torpedo as shown in Fig. 1. An output voltage, proportional to the torpedo's running depth is fed to an external recording device located immediately forward of the battery compartment. The exercise head is a dummy head with which the torpedo is fitted for testing and practice as contrasted to the war head that packs the torpedo's explosive Sunday punch.

The photographs show the acoustic transducer mounted on the torpedo's dorsal surface and the ultrasonic-recorder chassis withdrawn from its cylindrical housing. The recorder operates on a carrier frequency of 400 kc.

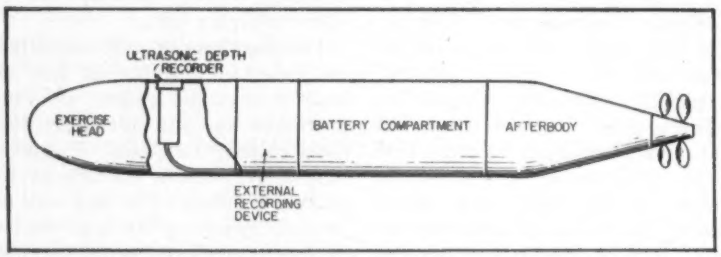


FIG. 1—Test torpedo fitted with exercise head. Cut-away shows depth recorder in place. Strip-chart recorder is forward of battery compartment

How Deep Does A Torpedo Run?

Study of torpedo performance on a test range requires knowledge of the torpedo's instantaneous depth throughout its run. The hydrostat, generally used for torpedo-depth measurement, operates much like an aneroid altimeter and responds only to average change of a rapid fluctuation.

The depth sounder responds to rapid fluctuations but indicates depth with respect to the ocean floor, a poor reference surface for torpedo-depth measurement. In deep water, the ocean floor may be out of range of a sounder suitable for installation in a torpedo.

The ocean's surface has been chosen as reference plane for torpedo-depth measurement despite surface irregularities that produce an inherently poor reflecting surface. Naval Ordnance Laboratory has developed an ultrasonic echo-ranging instrument that uses this air-water interface as a reflector.

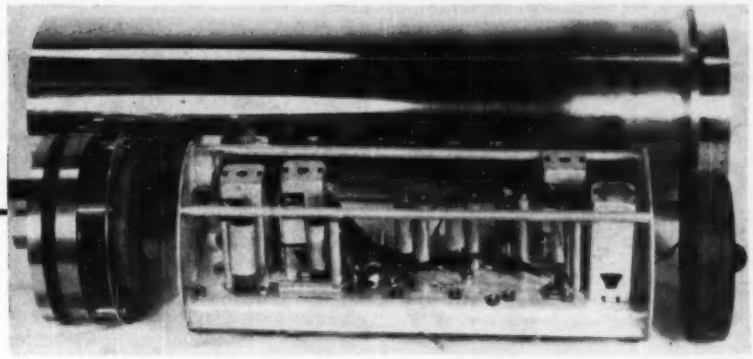
Reflection Problems

Air-water boundary, used as a reflector, is neither of regular shape nor unchanging with time. Variability of surface waves, travel of the torpedo, and large-scale temperature stratifications cause variations in pulse transit time. This appears as jitter in the return pulse position and an apparent fluctuation in depth.

Return-pulse amplitude fluctuation is also troublesome. This is caused by factors having to do with the propagation of sound in water and factors characterizing reflective properties of the air-water interface. The fluctuation in intensity, at a given point, is due to the reinforcement or cancellation of many signals arriving from different reflectors.

The effects of wave troughs upon echoes can be compared to dispersion of light by a convex mirror, while wave peaks act as a concave mirror. The net effect causes loss of echo. Other factors that affect

Gages Torpedo Depth



Depth recorder chassis is mounted in watertight cylinder with acoustic transducer forming top of can

Acoustic transducer is located on torpedo's dorsal surface

seriously return echo detection are noise properties of vehicle, pitch and roll of vehicle and directivity of the transducer.

Figure 2 is a block diagram of the depth recorder. Pulse width and repetition interval are set by a highly unbalanced free-running multivibrator. The ratio of repetition interval to pulse width is 50 to 1. Absolute repetition time determines the maximum depth that can be recorded while pulse width determines both minimum recordable depth and the required amplifier bandpass for most consistent echo detection.

The multivibrator provides three separate signals for recorder actuation. One signal turns on the gated oscillator. Coincident with this, a second signal turns off the tuned r-f amplifier and blocks the thyratron shield grid. The third signal, corresponding to the leading edge of the other pulses, sets the Eccles-Jordan trigger circuit in the on state.

Transmitter

The r-f pulse generated by the gated oscillator excites a tuned power amplifier, which in turn drives the acoustic transducer. The output of the power amplifier is also applied, through a diode limiter, to the input of the tuned r-f amplifiers. However the limiting action of the diodes and the off gate applied to the second stage of the tuned amplifier prevent signals from appearing at the amplifier output during the transmit interval.

Receiver

After an unlocking interval, which follows the transmitted pulse, the tuned amplifiers become active and await the echo signal from the transducer. Unlocking time is controlled by the time constant R_1C_1 (Fig. 3). After an interval corresponding to the time required for the pulse to travel to the air-water surface and return, an echo signal will appear. Since the signal is, in general, smaller in amplitude than the transmitted pulse, limiting by the diodes is practically nonexistent. The echo is amplified and the negative envelope obtained by a germanium-diode detector. The pulse is further amplified and inverted in a triode amplifier. Figure 4 illustrates waveforms present at various points in the circuit.

Because of the irregular char-

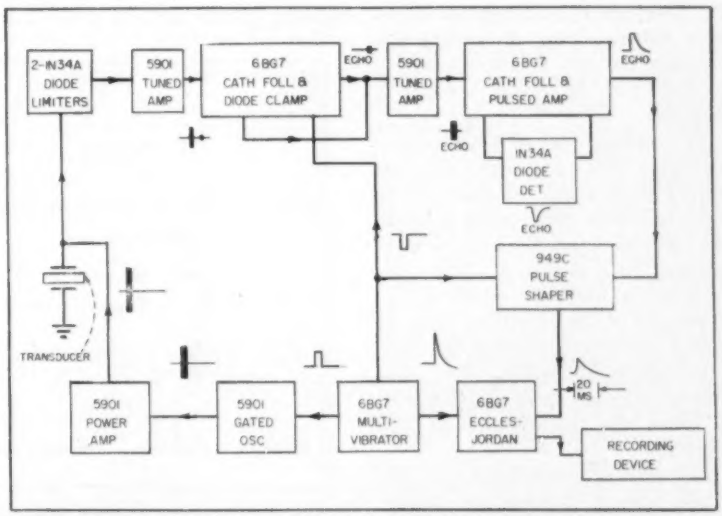


FIG. 2—Depth recorder employs ultrasonic transceiver. Variable-width pulse from Eccles-Jordan measures transit time of ultrasonic pulse reflected at air-water interface

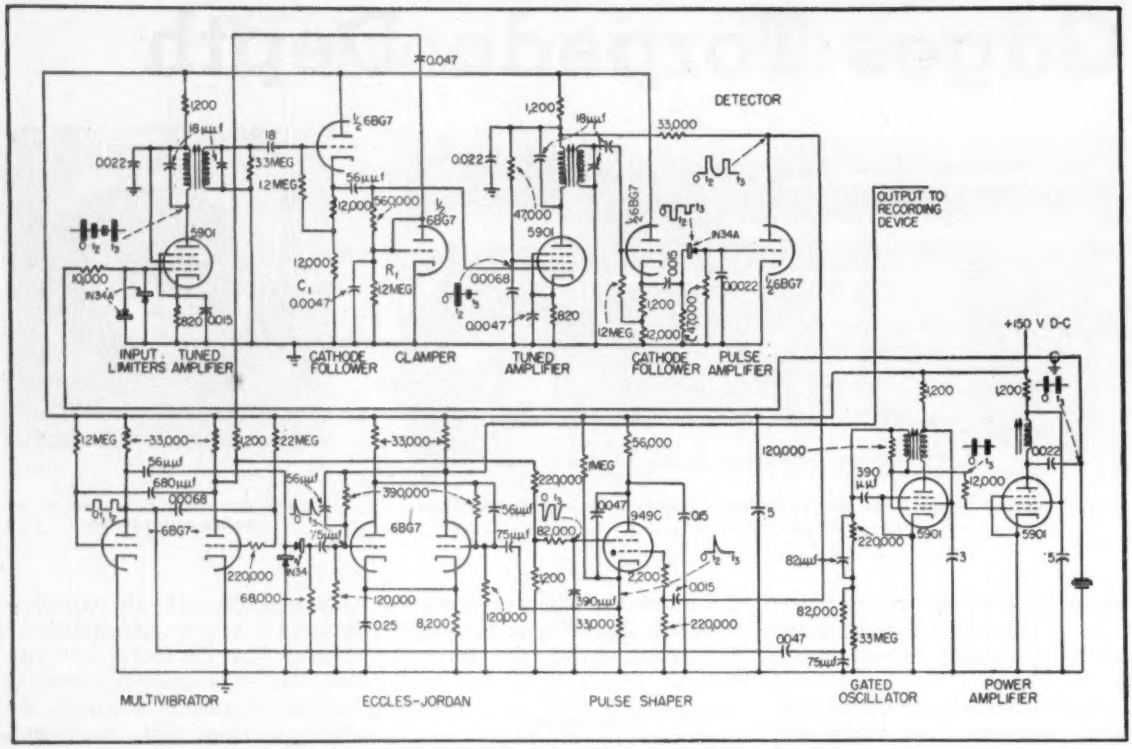


FIG. 3—Free-running multivibrator keys transmitter oscillator and Eccles-Jordan while disabling receiver and pulse shaper during main bang. Shortest-path echo fires thyratron to turn off Eccles-Jordan

acter of the air-water interface, there are many points on the surface that reflect signals and no single echo signal exists. The main or shortest-path echo is followed by a series of irregular echoes of diminishing amplitude as shown in the photograph. To prevent these false echoes from activating the recorder circuits a lock-out device is employed following the pulse amplifier.

The leading edge of the shortest-path echo fires a thyratron that immediately prevents any false echoes from effecting the timing circuits for a period determined by the time constant R_3C_3, in Fig. 3. This time constant is normally adjusted for 20 percent of the repetition interval since experience has shown that any false echoes appearing after that time are of such small amplitude as to cause no malfunction of the recorder.

The trigger spike from the thyratron circuit returns the Eccles-Jordan circuit to the off state. Thus a square wave of constant height whose width is proportional to depth is generated. An increase in depth results in a square wave of increasing width. The Eccles-Jordan is always in the correct state at the start of each pulse-repetition interval even if no echoes were received during the previous interval.

Integrated Output

To utilize the intelligence in the square wave it must be converted into depth indication that can be recorded for later analysis. One

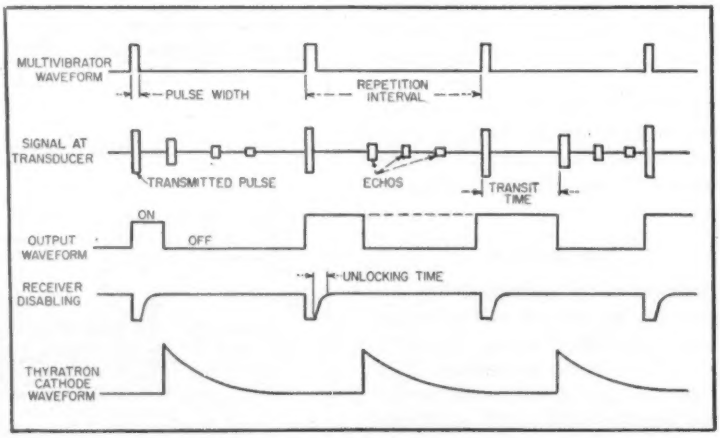


FIG. 4—Waveforms illustrate how multivibrator initiates recorder operation. Exponential decay of pulse provides 20-millisecond lock-out of spurious echoes

method is to integrate the square wave to produce a d-c potential proportional to depth. This signal could then actuate a conventional strip-chart recorder. However, if loss of echo occurs, there will be a sudden increase in apparent depth. However, if it is known that the torpedo cannot possibly change depth as suddenly as might be indicated, and if loss of echo occurs infrequently, this error can be resolved.

Another method that more clearly indicates malfunction of the recorder is to record the square wave on moving film. Any loss of echo is indicated immediately by a sudden widening of the square wave that returns to normal width within the next frame. This system is unsatisfactory from the standpoint of record analysis in that it requires point-by-point scaling of depth indications on a considerable quantity of film.

Boxcar Demodulator

A method that shows promise of accurate depth recording utilizes a modified boxcar demodulator. Figure 5 shows the operation of this circuit. A capacitor, C_1, is charged linearly in each pulse-repetition interval from a potential $V = V_0$ at $t_0 = 0$ to V at time t, where it is clamped until the end of the interval. Time $t - t_0$ corresponds to pulse transit time. At the end of the pulse-repetition interval, potential V is transferred to another capacitor, C_2, whose potential remains clamped throughout the next repetition interval while C_1 is returned to V_0. In the event that C_1 charges to $\overline{V}$ (maximum value of V) indicating loss of echo, C_2 maintains the potential determined during the preceding interval, and C_1 is again discharged to V_0.

Extrapolation is effected over a repetition interval for which no new information is available. This type of demodulation also provides filter action that essentially suppresses the pulse-repetition frequency and harmonics.

Demodulator requirements could be simplified if loss of echo could be completely eliminated. This is not possible, although, the probability of echo detection would be much enhanced by reducing the threshold setting of the thyratron. In this way more complete phase cancellation of echoes from two or more reflecting points would be required if malfunction of the recorder were to occur. However there is a limit to sensitivity increase that can be tolerated. This limit is set by the noise properties of the vehicle in which the recorder is carried.

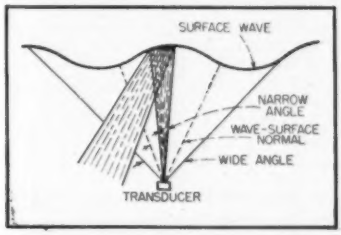


FIG. 6—Transducer sacrifices directivity to reduce loss of echo due to torpedo roll and pitch

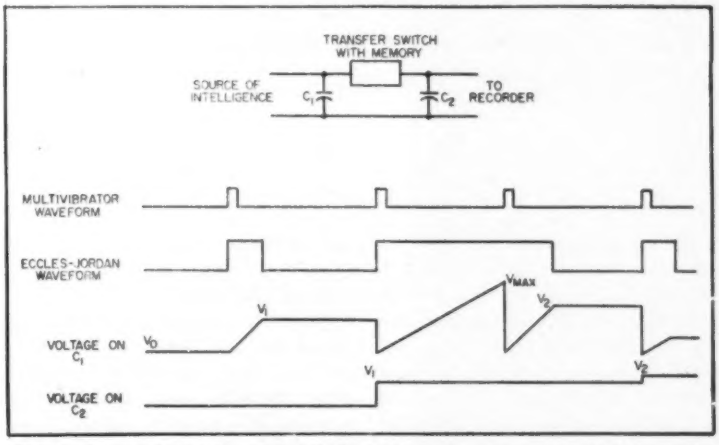
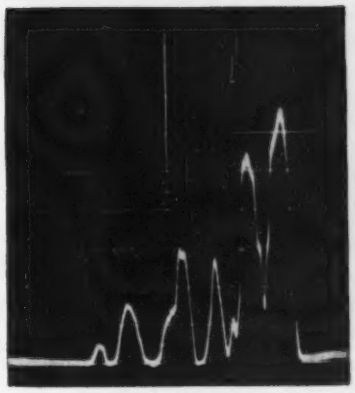


FIG. 5—Boxcar demodulator holds Eccles-Jordan output during repetition intervals in which echo is lost



False-echo return due to scattering at air-water interface. Lock-out bars all but shortest-path echo

Some increase in sensitivity can be accomplished by narrowing the bandwidth of the tuned amplifiers thereby effectively filtering out a greater number of noise-frequency components. However the limit to the amount of bandwidth reduction that can be tolerated depends upon pulse rise time. Too narrow a bandwidth results in an excessive rise time and decreases accuracy of transit-time measurement. A compromise must therefore be reached between the noise rejection and sensitivity.

Transducer Directivity

If the directivity pattern of the transducer employed is too narrow, loss of echo may result from the absence of a wave-surface normal. This is shown in Fig. 5. Torpedo roll and pitch, shallowest depth of operation and, to some extent, maximum length and height of surface waves encountered are factors determining the required minimum transducer angular coverage. For depth determination below five feet in water having surface waves 10 feet long and 1.39 feet high, a total transducer angle of 100 deg appears adequate. Because of reduced transducer sensitivity near the outer fringes of the radiation pattern, a transducer having a 150 deg radiation pattern is employed.

Cathode-Ray Tube Plots Transistor

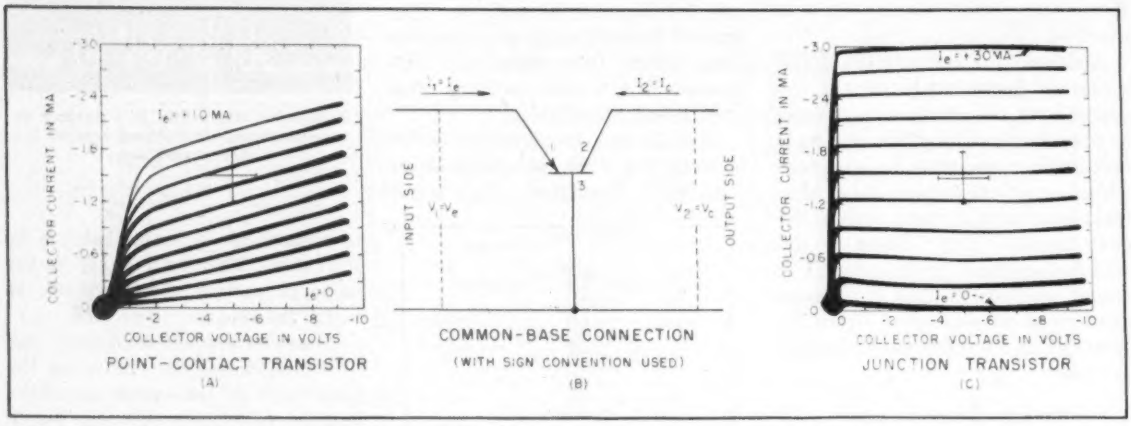


FIG. 1—Transistor output characteristics. Schematic (B) shows common-base connection used in deriving curves for point-contact transistor (A) and junction type (C)

Either point-contact or junction transistors can be tested and new power transistors under development will be handled. Electrode and transfer characteristics, automatically displayed on oscilloscope, may be photographed to provide circuit-design data

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TRANSISTOR CHARACTERISTICS are displayed automatically on a cathode-ray oscilloscope by the transistor-curve tracer to be described. The instrument accepts either point-contact or junction transistors. Both sweep and bias sources are designed to accommodate transistors of greater power-handling ability than those currently available although data gathering in the microwatt range was also a design objective.

Nine current ranges are available with full-scale deflections from 0.1 milliampere to one ampere. Full-scale sweep voltage ranges from 0.1 to 300 volts are provided with a 1,000-volt sweep range available at reduced current. The 1,000-volt sweep is also useful for determining peak back voltage on rectifiers.

Constant-current bias is provided in steps from 0.1 microampere to one ampere and constant-voltage bias is provided in steps from 0.1 millivolt to 10 volts.

The photograph shows a front-panel view of the transistor-curve tracer, which consists of four separate chassis: oscilloscope, sweep chassis, bias and d-c supplies. The transistor is connected to the receptacles at the right of the sweep chassis and its characteristics displayed on the oscilloscope face of

Curves

the chassis below.

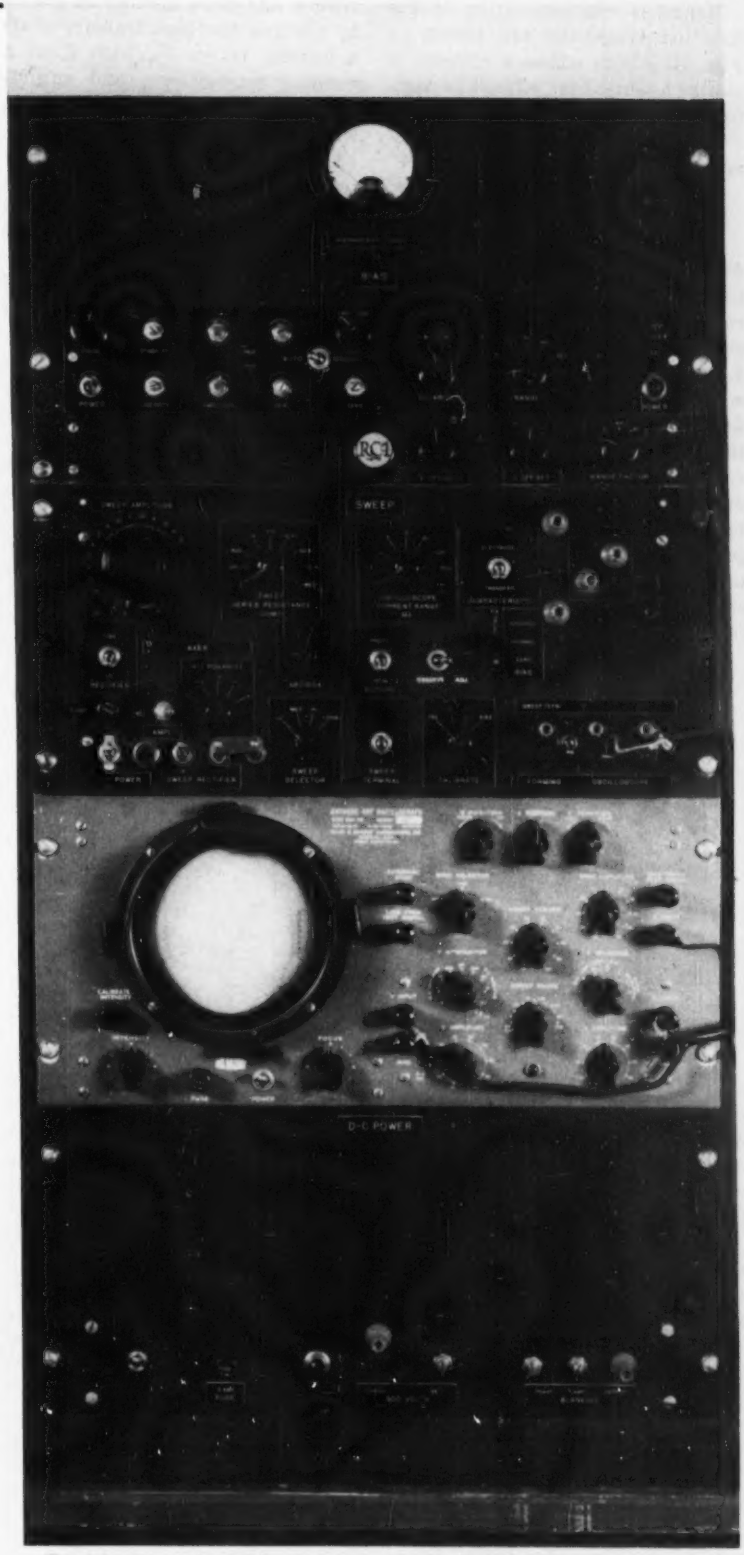
Either all four quadrants of a volt-ampere coordinate system can be displayed simultaneously or the entire scope face may be used to display one quadrant. Each of eleven curves in a family is automatically traced in sequence as the running parameter of the system is stepped. The long-persistance crt screen gives continuous presentation suitable for photographing and the coordinate axes are displayed with superimposed calibrations.

Transistor Characteristics

Some transistor characteristic curves obtained by photographing the scope illustrate the versatility of the curve tracer. Figure 1A is a family of curves showing collector characteristics of a point-contact transistor operated with common-base connection shown in Fig. 1B. A similar family of curves for a junction transistor is shown in Fig. 1C. In both cases, the emitter current, I_e, is varied in discrete steps to give the family of curves. Bias range for the point-contact transistor is one-third that of the junction transistor. The junction transistor's unity current gain may be contrasted with the greater current gain of the point-contact transistor.

To obtain maximum use of the scope face only one quadrant is displayed. For convenient comparison with other characteristics, the curves are shown in the first quadrant although both abcissa and ordinate are negative as indicated.

Figure 2 shows some characteristics of junction transistors with common emitter connection shown in Fig. 2B. Collector characteristics, Fig. 2A and C, are obtained as the base current is stepped from zero to −30 μa. Figure 2A shows one quadrant only while Fig. 2C



Curve tracer consists of four separate chassis. Transistor is connected to triple receptacle at right of sweep chassis; characteristics are displayed on scope face

is a four-quadrant display.

Transfer characteristics of the junction transistor are shown in Fig. 2D where collector current is plotted against base voltage as emitter current is varied from zero to −30 microamperes in three-microampere steps.

Requirements

A transistor is a three-terminal device whose behavior may be described completely by two equations relating its electrode voltages and currents. In functional notation, $V_1 = R_1 (I_1, I_2)$ and $V_2 = R_2 (I_1, I_2)$ where voltages and currents are defined in Figs. 1B and 2B. Since the two functions R_1 and R_2 are not readily represented analytically over extended ranges of their argument, it is desirable to display them graphically. The information contained in these graphs can then be applied to design problems in which the transistor is a circuit element. This information may be displayed with a minimum number of curves by plotting feedback transfer characteristic (I_2 vs V_1, with I_1 as a running parameter), and output-electrode characteristic (I_2 vs V_2, with I_1 as a running parameter).

The first set can be used to determine input power requirements and feedback effects. The second set is useful in deriving output characteristics such as power delivered to a load, distortion, and efficiency. The slopes of these curves, as well as of corresponding curves with I_2 as the parameter, also furnish information useful in analyzing small-signal, low-frequency behavior of a transistor. For point-contact transistors, it is convenient to use the base as the common connection and let 1 and 2 stand for emitter and collector (Fig. 1B). For simple junction transistors, base and collector are often preferred as 1 and 2, with the common (Fig. 2B) emitter circuit.

Visual representation of the functions on a d-c oscilloscope may be obtained by biasing one electrode with constant current and sweeping the other with alternating voltage. If, after each trace, the bias is stepped to a new value, an entire family of characteristics may be displayed sequentially. If the oscilloscope tube has long persistence, the display will appear continuous. The equipment to be described consists of multirange sweeping and biasing circuits with provisions for single and multiple displays.

Other families of characteristics may also be desired. For example, $I_1 = G_1 (V_1, V_2)$ and $I_2 = G_2 (V_1, V_2)$ are equivalent to the equations previously given and sometimes more useful. Their representation requires constant-voltage bias which is also provided.

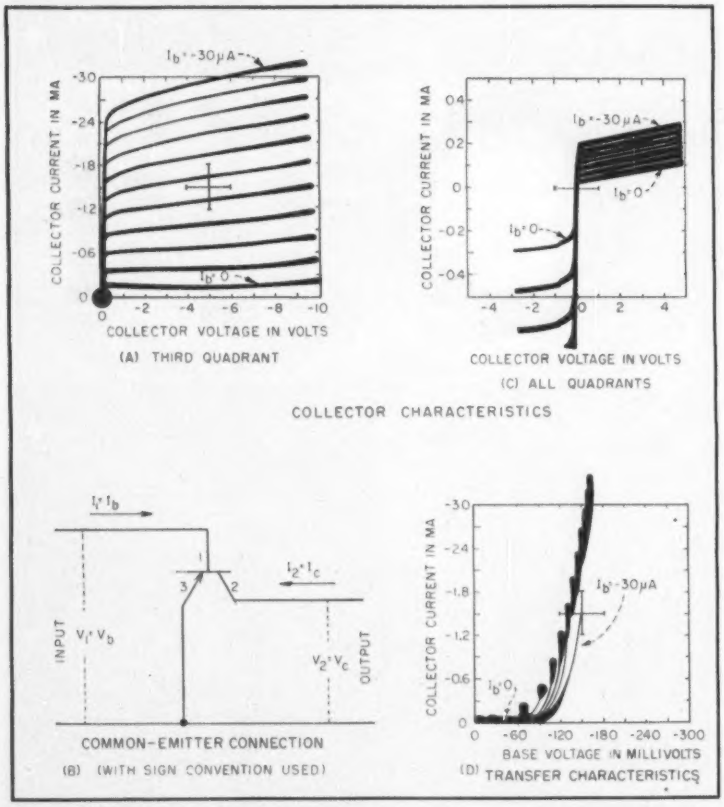


FIG. 2—Collector and transfer characteristics for junction transistor with common-emitter connection (B). Collector curves are shown for negative current and voltage (A) and for all quadrants of volt-ampere coordinate system

Sweep Circuits

A block diagram of the curve tracer is shown in Fig. 3. There is a sweep power supply (Fig. 4) consisting of a variable-output transformer and one of three additional transformers, which provide a continuous range of alternating sweep voltages from 0 to 1,000 volts. The maximum current available is one ampere at zero to nine volts or zero to 300 volts and 0.1 ampere at zero to 1,000 volts. A rectifier is included in series with the transformers to permit unidirectional sweep. Switch S_3 selects either an electrode or a transfer characteristic for display.

Positive-Current Bias

The transistor under test can be supplied with constant-current bias from a current-regulated source. Figure 5A shows a simplified schematic of the supply connected to deliver positive current with respect to ground to the load R_o. To keep one side of R_o at ground, the rest of the circuit must have a different common return point as shown. The circuit is almost the same as a conventional degenerative voltage regulator.

However, to maintain constant current in the load R_o, the load is connected in series with the feedback resistor R_f, rather than in par-

allel with it. A reference voltage, V_R, is applied to the grid of V_1, while a voltage proportional to the load current I_o is applied to the grid of V_2. The output at the plate of V_2 is proportional to $V_R - I_o R_f$ and appears at the grid of V_3 after amplification by the d-c amplifier. The impedance of V_3 thus changes until load current, supplied by a separate, unregulated supply, assumes a value very nearly equal to V_R/R_f. The differential output resistance of the regulator is approximately

$$r_{out} = r_{p3} + R_f\left(1 + \frac{\mu_1\mu_3 AR_1}{2\,r_{p1} + R_1}\right)$$

where: μ_1 = amplification factor of V_1 or V_2, r_{p1} = plate resistance of V_1 or V_2, μ_3 = amplification factor of V_3, r_{p3} = plate resistance of V_3, A = gain of the d-c amplifier and R_1 = load resistance for V_2.

The extremely high output impedance results in almost constant output current over a large range of load resistance R_o. Full-scale current ranges of 0.1, 0.3, 1, 3, 10, 30, 100, 300 and 1,000 milliamperes are provided by switching R_f and V_3. Within any one range, the current is set by varying V_R, which has a maximum value of 10 volts. Thus, the voltage fed back to V_3 and the grid bias required for V_3 can be kept within reasonable limits. The voltage required across the load R_o at any current I_o depends on R_o. In practice, this output voltage is limited to that which corresponds to the intersection of the load line ($R_f + R_o$) and the zero grid-bias line on the plate characteristic of V_3. Increasing either I_o or R_o beyond these values would require a positive grid-bias on V_3 which is not a suitable operating condition. About 50 volts are available on all ranges. Automatic over-voltage protection is provided since the regulator saturates at higher voltages under conditions of high I_o and R_o.

Negative-Current Bias

Figure 3 shows that the circuit has been arranged to permit the transistor to have one terminal connected to oscilloscope ground. It is therefore necessary that the feedback voltage across R_f be derived with respect to a common point other than ground. This common point must be maintained throughout the d-c amplifier and the reference stage. Capacitance C_1 (shown dotted in Fig. 5) between common and ground, together with R_f and R_o, form a closed loop around which objectionable hum currents may be induced. As long as these currents pass through both R_f and R_o, they furnish an error signal to the regulator and are, for the most part, suppressed. However, the regulator is ineffective in reducing these currents if either ground or common is placed at the junction of R_o and R_f. These considerations lead to the circuit of Fig. 5B when negative bias currents are required. With suitable switching and inversion of the reference voltage V_R, the circuit operation is equivalent to that giving positive bias current.

Zero output current is obtained when V_3 is biased to cutoff. However, with the positive output connection of Fig. 5A, hum currents may still flow through R_o and R_f while V_3 remains inactive. By bleeding current through V_3 by means of V_4 and R_4, conduction is maintained even at zero load-current in R_o and R_f. Hum currents are then suppressed in the usual manner. A similar bleeder is desirable for the negative output connection as shown in Fig. 5B, to help maintain linearity near zero load current conditions.

To supply constant-voltage bias for a transistor imposes problems

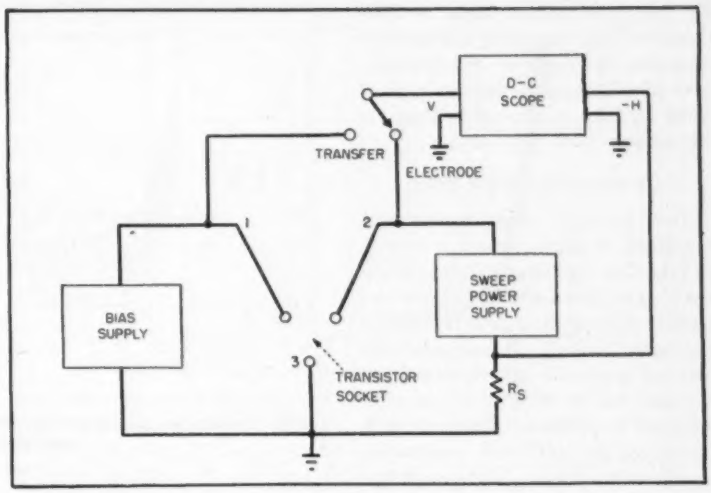


FIG. 3—Block diagram of curve tracer. Either electrode or transfer characteristics may be displayed. Sweep voltage is applied to one electrode while stepped increments of bias are applied to the other

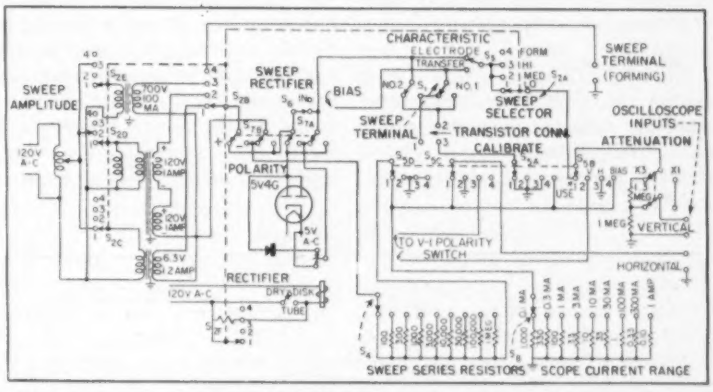


FIG. 4—Sweep voltage is obtained from transformers. Rectifiers select proper portion of alternating voltage waveform to produce desired display

not normally encountered in electronic voltage regulator design. For example, the emitter input impedance of a transistor may be tens of ohms and the maximum voltage required less than one volt.

Constant-Voltage Bias

The simplest way to provide regulated voltage to such a load is to take the regulated current from the bias supply described above and feed it into a fixed low resistance shunting the load. Thus, a one-ohm resistor adds voltage ranges from one millivolt to one volt at one-ohm internal impedance. To provide a 10-volt range, a 10-ohm resistor is also made available. Higher voltage ranges are not provided and would best be obtained directly from a conventional voltage regulator. An adjustable offset voltage, derived from a battery, can be added to the regulated bias voltage and is useful for automatic operation.

Microampere Bias Supply

Since junction transistors are commonly operated in a base input circuit, it is desirable to take characteristic curves with base current as parameter. With transistors having a low leakage current and current gain near unity, the total bias range of interest may be only a few microamperes. The current regulator already described cannot readily be arranged to provide such low currents because conventional tubes used for V_2 in Fig. 5 are not suited to the task. However, for these low currents, the direct method of using a voltage in series with a high resistance is especially suitable. The voltage is obtained as previously described. Ten volts are used in series with resistors varying from 10 megohms to 10,000 ohms to give microampere ranges from one to 1,000. An adjustable offset current is obtained here by adding a battery-derived voltage to that supplied by the electronic regulator.

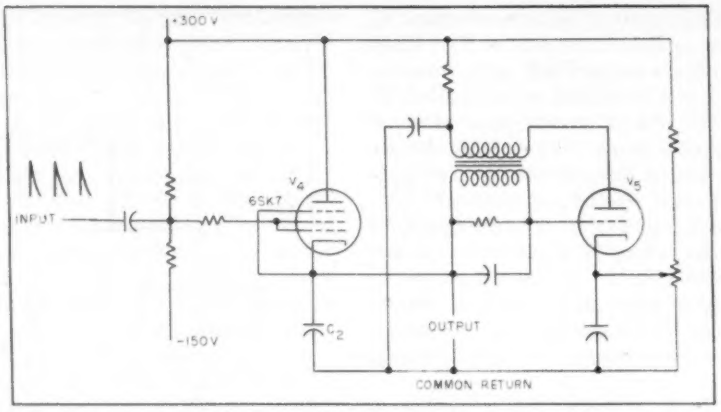


FIG. 6—Staircase generator steps bias current automatically to display family of transistor characteristics

Step Generator

A family of curves may be displayed sequentially if the bias current is stepped after each sweeping trace. The current steps are obtained by causing the voltage V_a to have a staircase waveform. The circuit for providing such a staircase is shown in Fig. 6. The charging tube V_4 is normally biased below cutoff. Sharp pulses at the input, derived from alternate half cycles of line voltage, drive the grid slightly positive and cause a charge to flow into the capacitance, C_2. An analysis of circuit operation shows that the necessary conditions for equal steps are readily met.

The staircase is applied to the grid of the discharge tube, V_5, a modified blocking oscillator biased below cutoff. The steps continue to build up until the blocking oscillator fires. The resulting grid current then discharges C_2 and allows the cycle to repeat.

The electrode connections used in V_4 are unconventional, but were determined empirically for best performance.

Transformers with an electro-

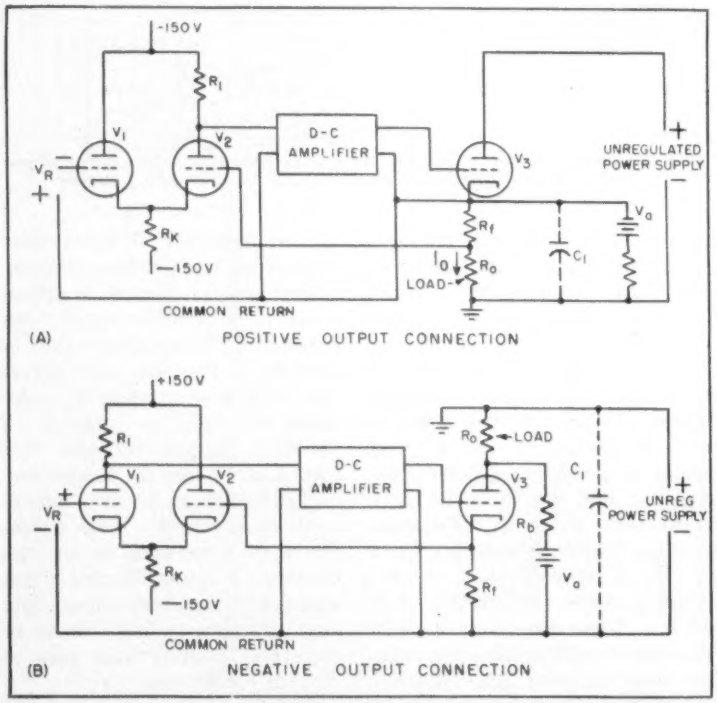


FIG. 5—Current regulator supplies either positive or negative constant-current bias to transistor's unswept terminal

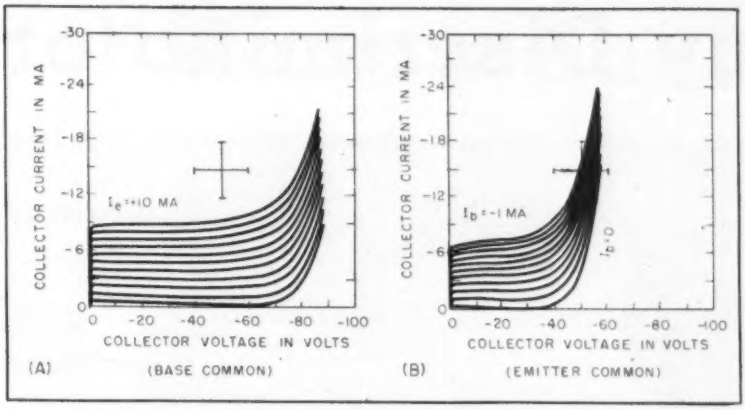


FIG. 7—Transistor-curve tracer implements study of collector breakdown voltage under varying bias conditions

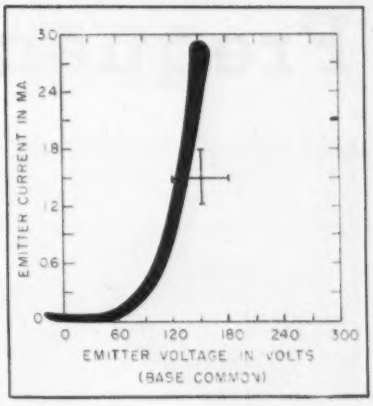


FIG. 8—Family of emitter characteristics

static shield are used to avoid spurious sweep voltages at low-level operation. Grounds to each chassis are made at a single point. The chassis are strapped together and to a good ground. Use of two phases of a three-phase distribution system simplifies phase-shifting in the blanking circuit. Precision resistors are used at all points that determine calibration of the pattern.

Construction Details

An interlock box fits over the test terminals to protect the transistor and the operator. This box must be in place to energize the 1-kv sweep transformer. If the box is removed, a relay disconnects and shorts the bias supply. If this were not done, the bias source would increase to its maximum voltage under the open circuit condition before a transistor is plugged in. On inserting a transistor with the interlock operating, the single characteristic for zero bias current will be displayed. By closing a spring-return switch, the complete family of curves may be viewed without replacing the interlock box. The transistor is protected from transients when switches are set to different ranges or polarities by the use of short-circuiting-type switches.

The oscilloscope has been provided with an illuminated scale to permit photographing calibrated axes along with the characteristic curves in a single exposure. An engraved transparent plastic disk is fiitted under the camera-mounting bezel and illuminated at its edges with small lamps. Intensity of illumination is set by a control on the oscilloscope panel.

As supplied, the *X*-amplifier of the oscilloscope has about one-tenth the gain of the *Y*-amplifier. To decrease the voltage drop required on the current sampling resistor *R*, (Fig. 3), more *X*-amplifier gain is desirable for the current display. The *X*-amplifier of the oscilloscope is, therefore, replaced with one equivalent to the *Y*-amplifier. A new centering control for this amplifier has been added to the oscilloscope panel; the *X*-amplifier gain control was not brought out to the front panel since it is reset only during calibration. The decade *Y*-attenuator of the oscilloscope, relabelled *V*-attenuator, is used in setting the voltage-scale calibration and has been supplemented with a three-times attenuator (Fig. 4).

Operation

The family of characteristics to be viewed is selected by choosing the terminal to be swept and utilized for the current deflection signal (terminal 1 or 2) and by choosing independently whether the same terminal is used for the voltage deflection (electrode characteristic) or the other one (transfer characteristic). Bias is automatically supplied to the unswept terminal.

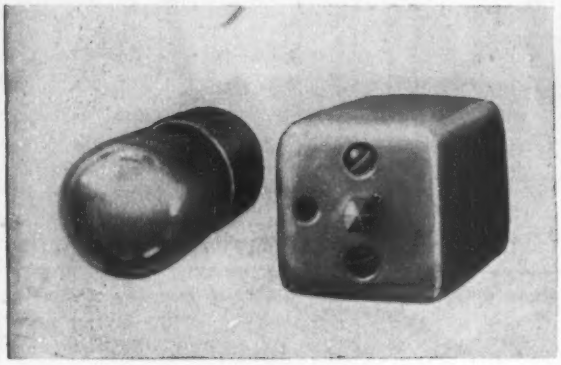
The circuit can be adjusted for different numbers of bias steps, but ten steps plus zero are preferred for a simple relation between the maximum and the incremental values of bias. Manual control of the bias supplied by the current regulator is also provided. The panel meter then reads the bias current. Under automatic operation, this meter reads the average current, normally the value of the middle step, and can be used to monitor the stepping circuit. Meter damping has been added externally.

Accuracy is limited in practice by the linearity of the step generator. The steps can be checked on the oscilloscope and adjusted for d-c level, amplitude, and linearity. Stabilized power supplies with good long-time behavior are used to maintain adjustment of the step generator.

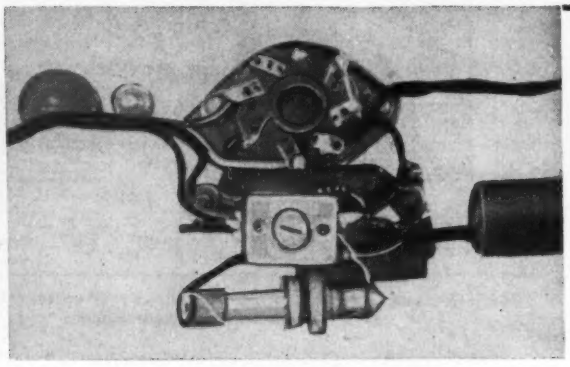
Studies of collector breakdown voltage and the influence of bias conditions are implemented by the curve tracer. In the collector family (Fig. 7A), breakdown voltages of the order of 80 volts are obtained when constant-current emitter bias is used. When the emitter is common and constant-current bias is applied to the base, the breakdown voltage is reduced to about 50 volts as shown in Fig. 7B.

Characteristics other than collector families are readily obtained. Figure 8 shows an emitter family with collector voltage as the parameter. All the curves are virtually coincident and appear as a single broad line. To obtain these curves, terminal 1 was swept rather than terminal 2.

Frequency Discriminator



Top view of narrow-band discriminator



Under-chassis view of modified circuit

DISCRIMINATION of narrow-band frequency modulation provides greater output when accomplished by a modified Foster-Seeley circuit than when a standard discriminator is used. The circuit, shown in Figure 1, is identical with the conventional circuit except for two component values.

Because of limited linearity, the circuit is not intended as a substitute for present circuits in general f-m work but for reception of frequency-shift-keyed teleprinter signals and narrow-band f-m voice communication. It has been possible to get solid copy on fsk teleprinter signals using only 150 cps shift. When measured at 425 cps shift, output of the modified discriminator exceeded by 2½ times that of the original circuit.

Foster-Seeley Circuit

Figures 2A, 2B and 2C illustrate vector voltages within the Foster-Seeley circuit for conditions at center, below-center, and above-center frequency respectively. Figures 2D, 2E and 2F show resultant rectified voltages and total output voltage under the same conditions.

At center frequency, primary and secondary of T_1 are both tuned to resonance. The voltage appearing across the secondary is 90 degrees out of phase with the primary voltage . The voltage across L is almost in phase with the primary voltage.

As the frequency shifts in either direction, the phase of the secondary voltage with respect to the primary voltage deviates from 90 degrees, either increasing or decreasing depending upon whether the frequency shifts upwards or downwards.

The voltage across L remains almost in phase with E_p, regardless of applied frequency. Thus, the only vector that changes with respect to E_p is E_s.

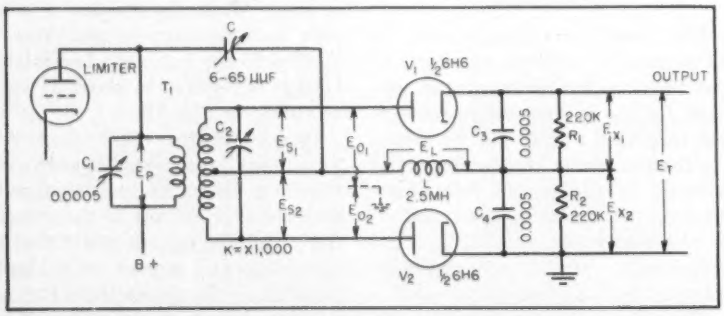


FIG. 1—Conventional discriminator is modified for narrow-band f-m by changing values of L and C to resonate above T_1 primary

In the modified circuit, the values of L and C are changed such that their resonant frequency will be slightly above that of the primary of T_1, instead of much below as in the Foster-Seeley design. The LC combination is tuned above center frequency an amount that will cause a difference of phase between E_p and E_L of 45 degrees.

Center Frequency

To get zero output at center frequency, the secondary of T_1 must be tuned below center frequency enough to allow 45 degrees phase difference between E_p and E_s. This results in 90-deg phase shift between E_s and E_L, the same as at center frequency in the unmodified circuit. The vectors are shown in Fig. 3A, 3B and 3C. The output voltages are shown in Fig. 3D, 3E and 3F.

Variable Output

As the applied frequency changes, the phase relations of E_L to E_p and E_s to E_p change equal amounts in opposite directions. Vectors E_L and E_s both move in opposite directions as the frequency is varied, while in the original circuit, only E_s moves.

For a given frequency shift, output from the modified circuit is about twice that of the Foster-Seeley discriminator. The output is a linear function of frequency for about one percent of center frequency. When used at an i-f of 456

for Narrow-Band F-M

Modified discriminator provides increased output for narrow-band f-m and frequency-shift-keyed teleprinter signals. Schematically identical with Foster-Seeley design, circuit requires changes in values of two components and special tuning procedure

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kc, it will work satisfactorily for a maximum shift of 4 kc. This is adequate for voice communication and more than enough for fsk teleprinter.

Tuning Procedure

It is not necessary that the phase shift of LC and T_1 both equal exactly 45 deg at center frequency, if the sum of their phase shifts equals 90 deg. This simplifies alignment and adjustment can be accomplished as follows:

Tune C_1 to resonance at center frequency.

Tune C_2 to resonance about one or two kilocycles below center frequency.

This can be done by setting C at minimum capacitance, applying the necessary signal to the input of the preceding i-f amplifier and measuring the d-c voltage at the output of the discriminator while tuning C_2 for maximum output voltage.

Finally, set the signal generator to center frequency, and adjust C for zero voltage at the discriminator output.

The circuit is now adjusted for phone work.

If a strong fsk signal is available, it should be tuned in and with the vertical plates of a scope connected to the discriminator output, C and C_2 may be adjusted simultaneously until maximum deflection is obtained.

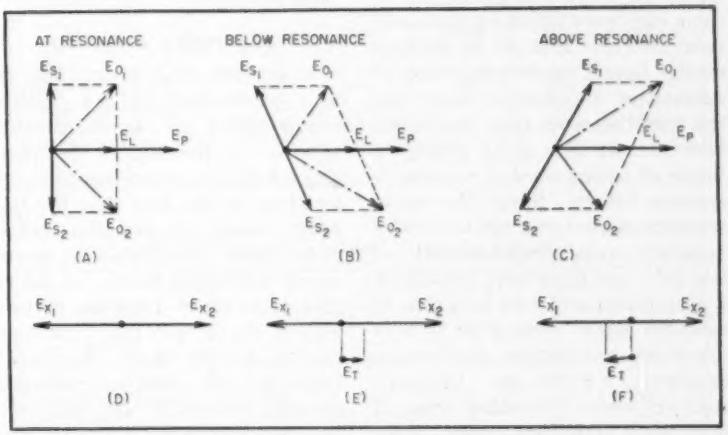

FIG. 2—Vector voltages, resultant rectified voltages and output voltages for standard discriminator

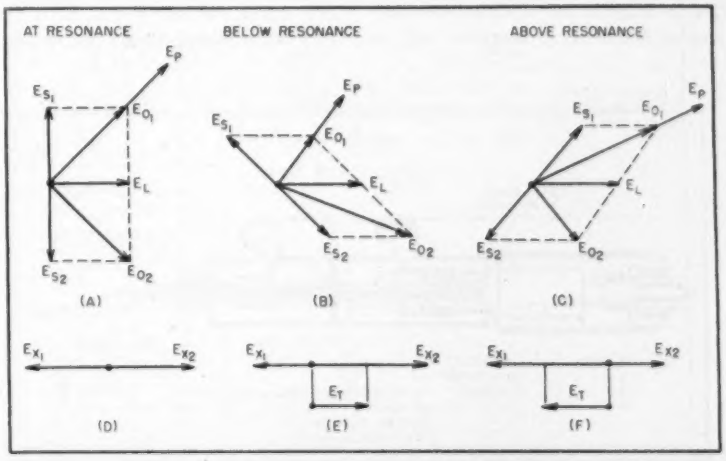

FIG. 3—Voltages for modified Foster-Seeley circuit show increased output for slight frequency deviation

New Developments in

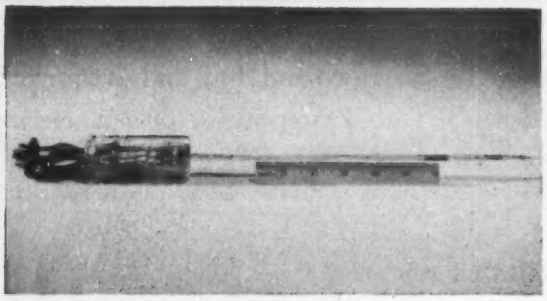

FIG. 1—Conventional traveling-wave tube with low-noise gun operates at 500 volts beam potential

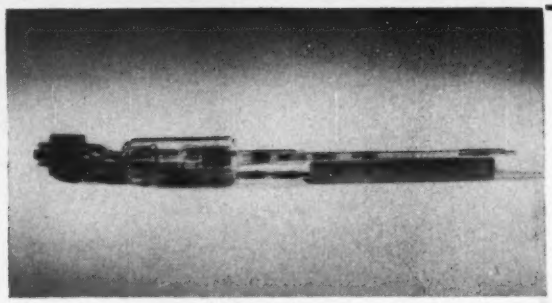

FIG. 2—Short tube uses folded-back antenna, bypass sleeve for input and collector for output coupling

PRACTICAL UTILITY of the traveling-wave tube[1] as an amplifier above 3,000 mc was questioned by some engineers following announcement in June 1946 of its development. Recent performance data of operational significance show that the traveling-wave tube is not only here to stay but is at present a factor of consequence in microwave systems design. Since the use of traveling-wave tubes can be divided naturally into considerations of low-level and high-level amplifiers, a description will first be given of research work leading to a very low-noise, low-voltage, input-stage amplifier at 3,000 mc. Comparisons are made with other types of microwave amplifiers. Next, operating data are given for low-voltage, medium-power amplifiers with fairly good efficiencies, intended for use in commercial microwave relaying at 2,000 mc. Mention will be made of narrow-band types with filter-helix circuits, and of packaged designs.

Low-Noise Amplifier

In general, work in this field has been conditioned by the probable requirements of communications service. In the case of the input-stage amplifier, consideration must be given to the fact that the type 416A triode is available, which gives about 10-db gain at microwaves with noise factors in the region of 14 db at 4,000 mc. Crystal mixers are in use that give noise factors of about 10 db. To compete fully, the twt must not only give greater bandwidth and gain, but also comparable noise factor, since this receiver characteristic greatly influences transmitter design.

For some time, attempts to reduce the noise factor of the helix-type twt below about 15 db met with no success. However, an extended series of analyses[2] of shot noise in long electron beams indicated that the noise originating from a space-charge-limited cathode, had the aspect of a standing wave in space, with alternate minima and maxima of shot noise recurring axially along the beam. Analysis and experiments showed that if the helix in a conventional twt amplifier were so placed that the beam began to interact with the applied signal near a noise minimum, the noise factor of the tube would be improved. Furthermore, optimum electrode arrangements and voltages for guns were found that produce a low-noise beam.

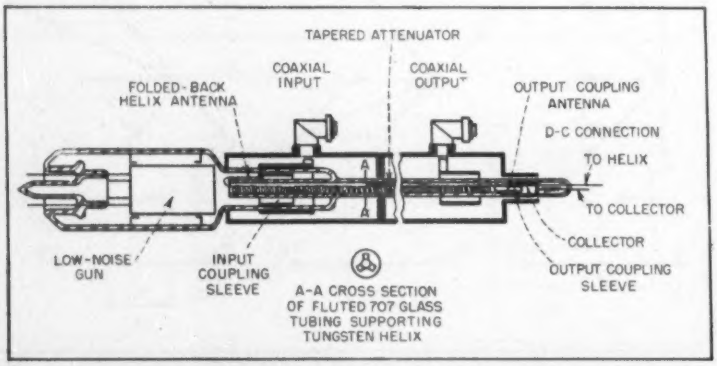

FIG. 3—Cross section of the tube shown in Fig. 2 with coaxial input and output matching transformers

Tube Constructions

Two typical low-noise traveling-wave tube constructions are shown in Fig. 1 and 2. The new design of Fig. 2 is a shortened version of the tube design of Fig. 1. Its cross-section is shown in Fig. 3. The input coupling antenna and sleeve are folded back and the collector is used as the output coupling sleeve to reduce the tube length to a minimum.

Table I indicates relative performance data for the twt and competing types in the 3,000-to-4,000-mc range. It is noteworthy that the operating voltage of the twt has been brought down to a low level strongly recommended by systems engineers in the interest of economy, reliability and compactness of equipment.

Traveling-Wave Tubes

Continuing research on low-noise tubes shows promise of noise factors between 8 and 9 db at 3,000 mc for wide-band amplifiers. Power amplifiers delivering several watts r-f output power at 2,000 mc will make possible improved microwave radio-relay service

By W. J. DODDS, R. W. PETER and S. F. KAISEL*

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Analytical investigation of an electron gun such as that shown in Fig. 4 with three accelerating electrodes *B*, *C* and *D* indicated that the first and second electrodes *B* and *C*, have to be at very low potentials, and the distance *B*-*C* has to be such that the noise current has a minimum at *C*, while the corresponding noise velocity fluctuations are a maximum at *C* as illustrated. Rapid acceleration of the beam up to helix potential at *D* reduces the velocity fluctuations considerably. Experimental tests on nine tubes of the type shown in Fig. 1 with this three-electrode low-noise gun yielded consistently low-noise factors.

There are some further basic requirements that have to be met in order to keep the noise factor at a minimum: (1) The emission should be space-charge limited over the entire cathode area. (2) No beam current (much less than one percent) should be intercepted in the gun or in the beginning of the helix. (3) No input signal power should be lost in the tube input region by reflection or attenuation. (4) No oscillations of any kind should exist in the tube.

Heavy Emission

The first requirement calls for a homogeneously emitting and well-activated eathode. To obtain a smoothed beam from an oxide-

Table I—Microwave Performance Data

Tube type	Frequency in mc	Noise factor in db	Gain in db	Bandwidth in mc	Plate voltage in volts
Traveling-Wave Tube....	3,000	8 to 9	≈20	200	500
Traveling-Wave Tube....	3,000	9 to 10	≈20	500	500
Triode (416A).....	4,000	14 to 20	10	100	250
Crystal Mixer.....	4,000	8 to 15	−6 to −8	8	....

Table II—Traveling-Wave Tube vs Triode

Tube type	Frequency in mc	Gain in db	Power output in watts	Efficiency in percent	Voltage in volts
Traveling-Wave Tube....	2,000	10	1.5	14	350
Traveling-Wave Tube....	2,000	16	5	16	600
Traveling-Wave Tube....	2,000	20	10	28	1,400
Triode (2C39-A).....	2,000	3 to 5	5	10	500

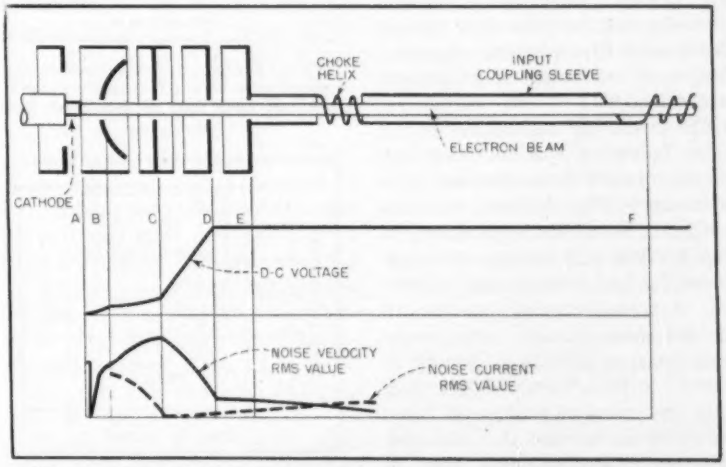

FIG. 4—Design principles employed in low-noise electron gun with three accelerating anodes

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Table III—Filter Helix Tubes

Frequency in mc	Gain in db	Power output in watts	Efficiency in percent	Noise figure in db	Voltage in volts
1,975	10	4.5	22.5		800
3,300	17	1/3	15		800
6,000	20				950
3,000	20			8	540
3,000	35			5	540

coated cathode, it was found necessary to have about ten times more emission current available than needed.

The second condition is extremely important as it can be computed that 1 percent current intercepted at the first helix turn will result in 10 db additional partition noise in the amplifier. The low-noise tubes quoted here have 0.096-in. inside-diameter helices enclosing 0.035-in. minimum diameter beams. The maximum beam diameter depends mainly upon the magnetic focusing field. This helix-to-beam-diameter ratio was found to be a good compromise between low partition noise and a large gain factor.

To meet the last two requirements a new wide-band coax-to-helix transformer of the form shown in Fig. 3 was developed. It consists of a short resonator in which the electric field is concentrated in a gap. The helix antenna is placed into this gap and excited by the field. If its radiation resistance and the helix impedance are adjusted to be equal, a wide-band match is obtained. The wide-band character of the circuit is seen from Fig. 5, which shows the cold insertion loss and the gain of a tube of the type of Fig. 2 and 3. A useful frequency bandwidth of 30 percent is obtained.

The frequency dependence of the noise factor of two low-noise twt amplifiers with three-electrode guns is shown in Fig. 6. Both are low-voltage tubes of the type shown in Fig. 1. The gun voltages were adjusted for best noise factor at 3,000 mc. A noise factor of less than 10 db was obtained over a frequency band between 2,800 and 3,300 mc in tube I. A noise factor of less than 9 db was measured between 2,900 and 3,100 mc in tube II. With the three-electrode low-noise gun of Fig. 6 it is possible to construct an S-band microwave amplifier with a noise factor of less than 10 db and a gain in the order of 20 db over a ±10-percent frequency band.

Noise Measurement

The noise-factor measurements were made with a gas discharge noise source[3], which is the essential part of a continuously monitoring noise-factor meter described elsewhere.[4] The absolute accuracy of this standard is within ±0.5 db as obtained by comparison with a hot waveguide, the relative probable error of the noise factor measuring system is less than ±0.1 db.

Power-Amplifier Tubes

Another general application possible for the twt is as a microwave power output tube. In the regions above 2,000 megacycles the gain-bandwidth figure for triodes begins deteriorating. Ability of triodes to deliver sufficient power with long life and reliability is likewise compromised. The klystron suffers somewhat in that it is difficult to obtain large bandwidths consistent with adequate gain and efficiency, a major difficulty being the high voltages required.

It was felt that long life might well be achieved in the twt compared to the triode because of the fact that the cathode is practically isolated from the beam collector and less subject to contamination; the collector is not part of the r-f circuit and can be cooled more conveniently. No part of the r-f circuit need intercept direct current that would aggravate any heating due to signal currents. A typical specification for a relay system at 2,000 megacycles requires a power amplifier to deliver 5 watts or more with over 10-db gain at a maximum voltage of 750 volts.

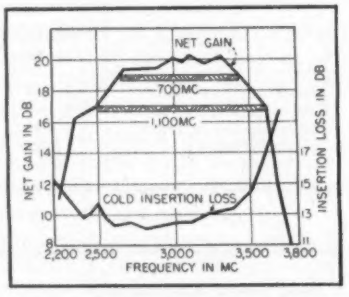

FIG. 5—Net gain and cold-insertion loss curves vary owing to imperfect match between helix and coaxial input and output lines

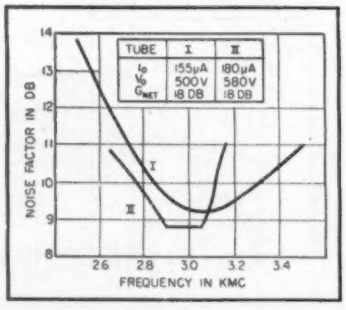

FIG. 6—Noise figures of two tubes as function of frequency

Since the present status of high-level theory is quite unsatisfactory, a largely experimental approach was made to determine what could be done to satisfy this application. The data in Table II indicate some results obtained with experimental traveling-wave tubes as compared with triodes, in a relay system under development for use in the 1,750-to-2,250 mc band.

Figure 7 shows a traveling-wave power amplifier for operation in the vicinity of 2,000 mc, in comparison with a standard 6L6. The twt length in this case is only slightly greater than seven inches. The reduction in size from that of the usual tubes designed for this frequency and voltage has been effected by folding the input-coupling antenna back over the helix. Later designs have incorporated this fea-

FIG. 7—Medium-power tube compared with type 6L6

ture in the coupling antennas at both ends of the helix.

Filter-Helix Tubes

In many applications the extreme bandwidth characteristics of the helix circuit is not utilized. This makes possible the use of a narrow-band interaction circuit. Fundamentally, artificial attenuation is required in helix-type traveling-wave tubes because of the difficulty in securing reflectionless helix terminations over the very wide amplification band of this type of tube. It is generally assumed that at some point in the helix amplification band, complete reflection will occur at one or both ends.

To prevent this reflection from resulting in regenerative oscillations, attenuation is introduced that exceeds the net gain of the tube. This condition automatically prevents oscillation at any other frequency for which the terminal reflections are large. If, instead of a uniform helix, another form of interaction circuit is used for which the phase velocity of the growing wave can be made to coincide with the electron-beam velocity over a narrow frequency range only, amplification can be limited to this narrow range. One need not, then, be concerned about large terminal reflections outside this range, since those waves are not amplified.

Because, as a rule, good matching is possible within limited frequency ranges, it now becomes possible greatly to reduce the artificial attenuation. In fact, it is often possible to depend entirely upon the unavoidable losses in the transmission structure to provide the attenuation needed since perfect match over a finite frequency band can never be achieved. Because circuits of the type desired, wherein the phase velocity is fairly uniform over a narrow frequency band and changes rapidly outside this band, behave like band-pass filters, tubes employing such structures have been designated filter-type tubes. Certain of their characteristics are listed in Table III.

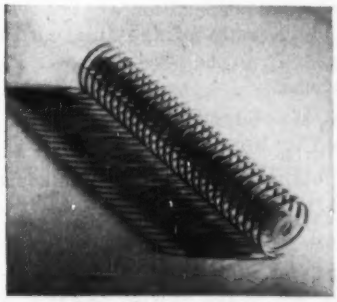

FIG. 8—Internal structure gives filter characteristic

Uniform transmission lines, which are wide band in performance, are distinguished from iterated filter networks, which are narrow band. The former has uniform impedance and the latter has localized repetitive changes in its impedance. This suggests that by introducing the feature of nonuniformity into a helix the desired goal of filter-type behavior can be achieved while retaining the advantages of the helix. Such a circuit has been designated a filter helix.

Various means of accomplishing this result suggest themselves. Figure 8 shows a helix loaded once in each turn with a capacitive element. In this structure the beam travels through the openings in the capacitive loading disks. Figure 9A shows a structure in which the objective is attained by coupling an external filter helix to a plain inner beam-interaction helix. By making changes in the outer helix, the range of operating frequencies can be selected. A filter-helix circuit can be made by introducing the repetitive impedance discontinuities as sudden changes in pitch shown in Fig. 9B. A low-level amplifier for 3,000 mc, made according to this principle, and utilizing the increased impedance characteristic of this structure, gave a noise factor slightly below 8 db at 20 db gain, and a noise factor slightly below 8.5 at 35 db gain.

An added advantage of filter-helix structures is that they can be considerably more rugged than the conventional helix designed for the same frequency. This is exemplified by the helix of Fig. 8, which was designed for a medium-power amplifier at 1,900 mc. When incorporated into a tube, 4.5 watts output was obtained with 22.5-percent efficiency.

Figure 10 is a schematic phase velocity versus frequency characteristic for a filter helix. The operating data given above are for region I (the first passband) although successful tests have been made in region II (the second passband).

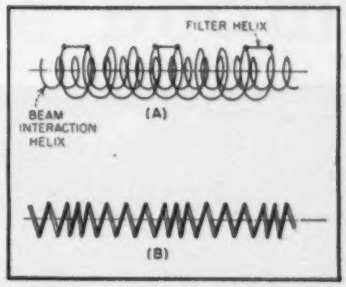

FIG. 9—External filter helix (A) can be changed to select operating frequency of tube containing inner helix or impedance discontinuities can be introduced by changes in helix pitch (B)

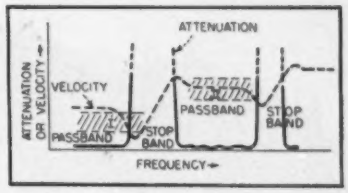

FIG. 10—Phase velocity versus frequency for a filter helix

Focusing Magnet

A necessary adjunct in the use of present traveling-wave tubes is a magnet to generate a focusing field for constraining the relatively long electron beams from striking the helix. An electromagnet is not attractive as a systems component because of its excessive size, weight and power consumption. Electron-optical data on the tube shown in Fig. 7, placed in a magnetron-type electromagnet with hollow pole pieces, indicate that permanent focusing magnets can be designed by standard procedures to permit packaging the twt in a manner analogous to the standard practice for radar magnetrons.

A portion of the work on the low-noise amplifier was done under the sponsorship of the Signal Corps under Contract No. DA36-039-sc-5548.

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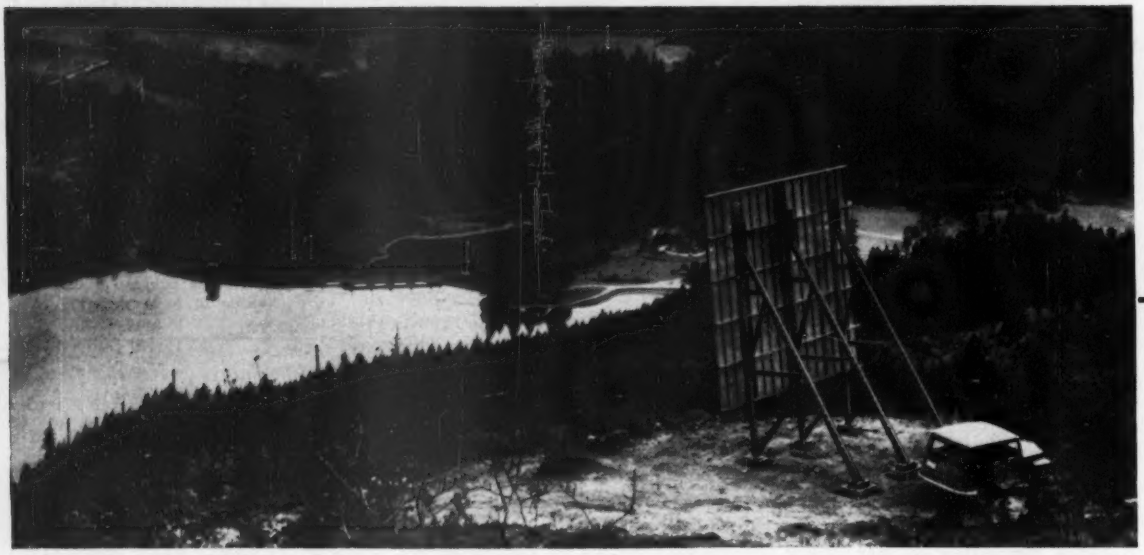
Passive Repeater



Signal path from the passive repeater (right, compared with jeep) lies over Merwin Dam to the station just visible (upper left)

BECAUSE intervening hills prevent direct line of sight, a passive repeater was built to reflect microwave beams around a bend in the Lewis River in western Washington. By this means, the Pacific Power and Light Company can control its new 100,000-kilowatt installation at Yale Dam from the control room at existing Merwin Dam, some twelve miles down river.

The most economical and reliable communication medium in this rugged country was found to be a microwave system in the 6,700-megacycle band, including full duplicate standby radio-frequency equipment and automatic switchover circuits. The equipment utilizes a frequency-division multiplexing system with separate frequency-modulated subcarriers for each voice channel. The microwave carrier frequency is modulated by all the subcarriers. Usage of the channels is shown in Fig. 1.

System Requirements

A glance at the contour map of Fig. 2 shows why it was necessary to use a passive repeater, defined as a large reflector (or a periscope combination of two large reflectors) which passively receives and retransmits a signal similarly to an electronic repeater, but without adding power. The usual electronic repeater cannot be used since a power line to this isolated spot would prove about as expensive and vulnerable to outages from natural causes as a multiple-pair cable between the two stations. Then, too, access to the location can be had only by laborious hill climbing on foot or, in good weather, by jeep over an unused logging trail.

The repeater attenuation may be evaluated by use of a well-known propagation equation that relates the received power P_r to the transmitted power P_t, the effective areas of the receiving and transmitting antennas A_r and A_t, the distance s, and the wavelength λ

$$P_r = P_t A_r A_t / s^2 \lambda^2$$

Since a passive repeater is a reradiator of energy rather than being analogous to an optical mirror, it can be considered first as a receiving antenna and then as a transmitting antenna reradiating the received power and this equation is applicable to each of the two legs of the total path. Hence, power received by the repeater P_r is

$$P_r' = P_t A_r' A_t / s_1^2 \lambda^2$$

And the power received from the repeater P_r is

$$P_r = P_t' A_r A_t' / s_2^2 \lambda^2$$

Since the repeater receives and transmits with the same surface and its efficiency approximates one-hundred percent

$$A_r' = A_t' = A$$

and

$$P_t' = P_r'$$

Hence

$$P_r = P_t A_r A_t A^2 / s_1^2 s_2^2 \lambda^4$$

Extension of this equation to a path containing N passive repeaters makes it of the form

$$P_r = \frac{P_t (A_r A_t A_1^2 A_2^2 \ldots A_N^2)}{(s_1^2 s_2^2 \ldots s_{N+1}^2) \lambda^{2N+2}}$$

However, in this case only one passive repeater was to be used. Hence, the total attenuation in decibels, being a ratio of the transmitted power P_t to the received power P_r, becomes

$$\alpha = -10 \log [A_r A_t A^2 / s_1^2 s_2^2 \lambda^4]$$

With no passive repeater, the attenuation over a path of this same length is

$$\alpha_o = -10 \log [A_r A_t / (s_1 + s_2)^2 \lambda^2]$$

And, by subtraction, the attenuation due to the passive repeater is

$$\alpha_R = -10 \log [A^2 (s_1 + s_2)^2 / s_1^2 s_2^2 \lambda^2]$$

Bends Microwave Beam

Perforated aluminum screen of 480-sq-ft area picks up 6,700-mc beam and reradiates it with only 7-db loss. Repeater located on hillside effectively bends telemeter and telephone signals 1,800 feet below optical horizon

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It can be seen that the passive-repeater attenuation can be reduced by increasing the reflector area or the frequency (decreasing the wavelength) while maintaining the other factors constant. Since the location of the reflector in the center of the path will give the greatest attenuation, it should be located as close as possible to one of the terminals.

The fading margin is defined as the difference between the path attenuation at which minimum communication can be maintained (105 db in this case) and the actual path attenuation. For conservative design, the fading margin chosen was 33 db, making the design objective a path attenuation of 72 db.

Antenna Sizes

Effective area of the 40-inch diameter receiving and transmitting antennas (with an efficiency of 0.624) is 5.45 square feet and the average wavelength used is 0.148 feet (corresponding to 6,645 megacycles). In this system, the distances were 1.236 miles and 11.052 miles. Hence, the required effective area of the passive repeater was calculated to be 384 square feet.

The effective area of the passive repeater is, of course, its projected area times its efficiency. Since the energy passing through the perforations of a microwave reflector has been measured as 0.1 percent of the incident energy and it is estimated that 0.1 percent of the incident energy is converted to heat, the efficiency of a flat reflector can be taken as 99.8 percent. In this

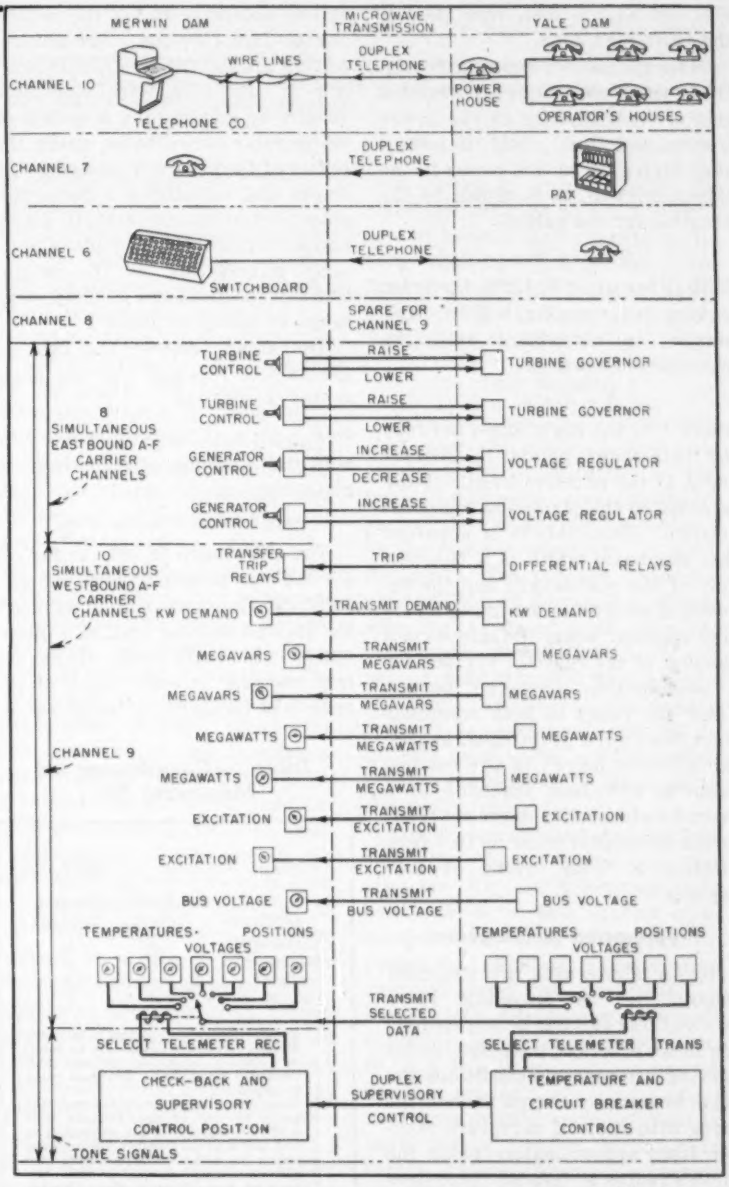

FIG. 1—Channel utilization in microwave control systems between Merwin and Yale dams shows functions possible with five existing subcarrier channels. Seven additional channels, not yet installed, can be made available

installation, the included angle between the incident and reflected beams was found to be 75.81 degrees. From this, it was calculated that the actual area required for the passive repeater was 488 square feet. The standard reflecting surface used in such installations is one-sixteenth inch aluminum sheet, four feet by six feet, perforated with 0.200-inch holes spaced one-quarter inch apart to reduce the wind resistance. Twenty of these sheets can be arranged on a twenty by twenty-four foot surface to provide 480 square feet, very close to the calculated area.

Since the passive repeater is relatively small and distant, it receives only a small fraction of the power transmitted to it. Still, it adds a very high gain to this power in the retransmission, as is shown by the equation for the gain G

$$G = 4\pi A/\lambda^2$$

With this gain of 217,000, the beam leaving the repeater will be very narrow, in accordance with the approximate formula

$$B = 60\ \lambda/L$$

where B is the beam angle between the half-power points in degrees and L is the effective length of the reflector in the plane under consideration. From this it is apparent that the beam width is a function only of the wavelength and the repeater dimensions (assuming a parallel incident beam or appropriate shaping of the reflector surface for a considerably diverging beam.) Since the paths to both terminals slant downward at different angles, the effective length in the vertical plane is 19.9 feet, resulting in a beam height of 0.45 degrees. That in the horizontal plane is 18.9 feet, yielding a beam width of 0.47 degrees.

Propagation Assumptions

While microwaves are generally thought of as traveling in a straight line and can be so regarded for most practical purposes, under varying atmospheric conditions the beam is actually curved around the earth with radii of curvature varying from approximately twice the earth's radius to infinite (true line-of-sight propagation). The radius is normally assumed equal to four times that of the earth in a so-called standard atmosphere. Calculations on this basis show that the receiving antenna will remain well within the one-db points of the reflected beam, even for extreme beam curvatures.

To satisfy the laws of reflection, the passive repeater must be so positioned that the angle its face makes with the beam from one station is equal to the angle it makes with the beam to the other station. Since both terminals are at lower altitudes than the passive repeater, it was necessary to tilt the reflecting surface forward. The amount of this tilt and the geographic bearing of the face were calculated readily by establishing a system of rectangular co-ordinates, using the center of the passive repeater as the origin and visualizing a horizontal plane, a vertical north-south plane, and a vertical east-west plane mutually intersecting at the origin. The various distances involved were taken as shown in Table I.

The angle between the face of the passive repeater and the horizontal is given by

$$\cos^2 H = (du + ct)^2/2\,dt\,(aw + bv + cu + dt)$$

and the bearing of the face is given by

$$\tan B = (dv + bt)/(dw + at)$$

The site chosen is only as far up the hill as was necessary to provide sufficient clearance and is athwart the unused logging trail at a place where it is nearly level. Hence, no tree removal or even brush clearance was required, it being necessary only to set the concrete foundation piers in the proper position. The ground in front of the passive repeater drops so quickly that there is no danger of growing brush obscuring the reflector. This location at the edge of a relatively level area of a number of acres is expected to make it unlikely that snow will drift against the reflector face, since its lower edge was placed five feet above ground.

Table I—Co-ordinates for Measuring Tilt

Passive Repeater (Origin) to		
Distance[1]	First Antenna	Second Antenna
North-south...	a	w
East-west.....	b	v
Vertical[2].....	c	u
Air line.....	d	t

(1) Parallel distances measured in the same direction from the origin may be taken as positive, while one of any pair measured in opposite directions must be negative.

(2) Must be corrected for curvature of the earth by use of the formula $h = 0.667\,m^2$, when h is the correction in feet and m is the distance between the points in miles. Add h when the passive repeater is higher than the antenna and substract when the antenna is higher.

Effect of Hydrometeors

So-called silver thaws are not uncommon in the area and may coat the reflector with ice. Being a good reflector in itself, ice will affect the signal only to the extent it roughens the surface and then in accordance with the formula given later for calculating the effect of surface roughness.

Slush, or wet snow, does interfere considerably with reflection, but it is considered unlikely that it can adhere to the forward-tilted surface.

It is to be noted that total obscuration of half the surface will result in nothing more than a 6 db drop in received signal strength. The system design fading margin of 33 db, then, assures that the threshold of limiter action will be reached only after the reflecting surface is reduced to 2¼ percent of its total area or eleven square feet.

Reflection will approximately double any horizontal angular movement of the passive repeater and will multiply vertical movement by 1.6. This effect combines with the narrow beam angle previously calculated to require that the structure be rigid enough to resist vertical distortion beyond 0.14 degrees and horizontal distortion beyond 0.12 degrees, even when coated with ice and buffeted by sixty-mile-per-hour winds, since it is desired to maintain the loss below 3 db under these conditions.

The design used to satisfy all of the above conditions is an aluminum structure, similar to a large billboard, supported by three A-frames, the back legs of which are built of three six-inch channels welded so their backs partially enclose a two-by-six inch box section, which is completed by welding in a two by one-quarter inch strip. The

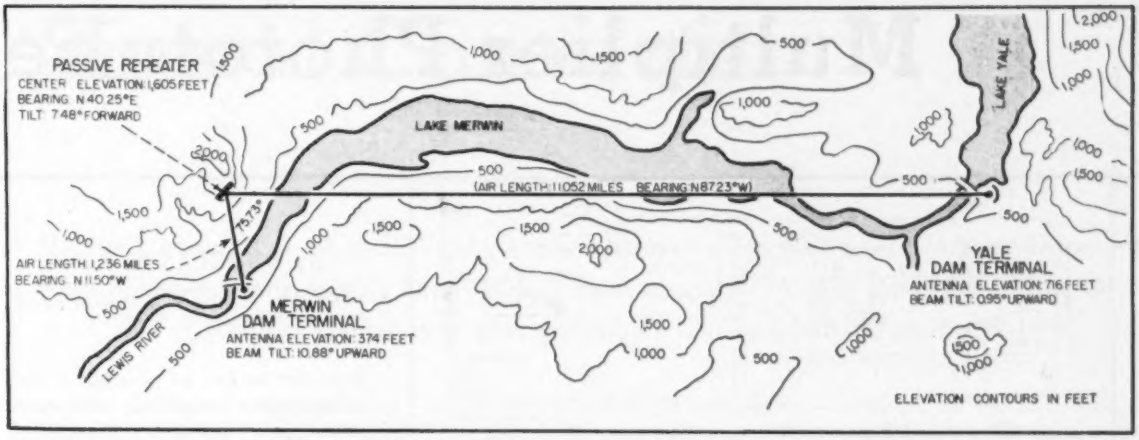

FIG. 2—Map of Lewis River, Washington, region shows how topography affects microwave control and communications between new Yale Dam and existing Merwin Dam downriver

front legs consist of two six-inch channels welded on opposite sides of a similar box and the cross braces are two-by-six boxes made from a six-inch channel with a one-quarter inch plate welded in the open side. These fit neatly into the front and back legs. The A-frames are tied together by six five-inch channels that constitute the backing for the reflecting panels. The whole structure is designed for bolted assembly in the field and the perforated sheet aluminum reflecting surface is shop-attached with drive screws to shop-welded six-by-twenty-foot panels. These are made of three-inch channels with two by one and one-half inch angles to stiffen the one-sixteenth inch sheet.

Flatness Factor

Since a surface as large as this cannot be made truly flat, it was necessary to calculate the effect of its lack of flatness. The energy reflected from a surface displaced forward or backward from its neighbors will be out of phase with the remaining energy by an angle P in degrees

$$P = (360)\ 2h/\lambda \sin R$$

where h is the displacement in feet and R is the angle between the surface and the incident beam. This shows that a spot displaced 0.177 inch will reflect energy ninety degrees out of phase with the main reflection, thus neither adding to nor subtracting from the main beam. This was taken as the limiting case and the flatness tolerance was specified as one-eighth inch.

Aluminum was chosen for the structural material so any tendency to buckle due to thermal stresses would be avoided by the uniform rate of thermal expansion or contraction of the entire structure. In addition, by specifying all aluminum hardware, the possibility of electrolytic corrosion was eliminated, periodic protective coatings were made unnecessary, and individual structural elements were light enough to make for ease in transportation and erection.

To be prepared for contingencies and to permit reasonable tolerances in fabrication and erection as well as allowing adjustment to prove the accuracy of the calculations, the base of each leg was equipped with slotted holes through which the studs anchored in the foundation passed. These provided for bearing changes of up to one and one-half degree in either direction from the midpoint. Alterations in tilt were made with jack screws in each foot and shims were provided to allow permanently securing the structure at a tilt of one degree more or less than planned.

Optimum alignment was accomplished by first adjusting each of the terminal antennas to give peak limiter readings on a transportable microwave set temporarily activated at the repeater site.

With the passive repeater in the position calculated by the formulas presented, a strong terminal-to-terminal signal was present, and it was necessary only to scan the structure through a small portion of the built-in adjustments to insure optimum positioning. The final position varied from the calculated by 0.02 degree in bearing and 0.05 degree in tilt.

Test Results

Actual attenuation in each direction over the installed path was measured by substituting a calibrated i-f amplifier successively for each of those in the main and standby microwave receivers at each terminal. The average measured value of 72.0 db agreed very closely with the calculated attenuation for the actual system of 72.1 db and proved definitely that the increase in attenuation due to the passive repeater is very small, only 7.0 db in this case. The actual fading margin available is 33 db, equal to the design objective.

The formulas cited demonstrate that the high microwave frequencies (in the 6,700-megacycle band) used on this system have special value when a passive repeater is required. Lower frequencies would have resulted in a higher path attenuation or a considerably larger passive repeater. Putting this installation in service has also proved that it is practical to assume an efficiency very close to unity for a passive repeater in future systems if careful attention is paid to achieving flatness in structure design, fabrication, and erection.

Multiplier Phototube

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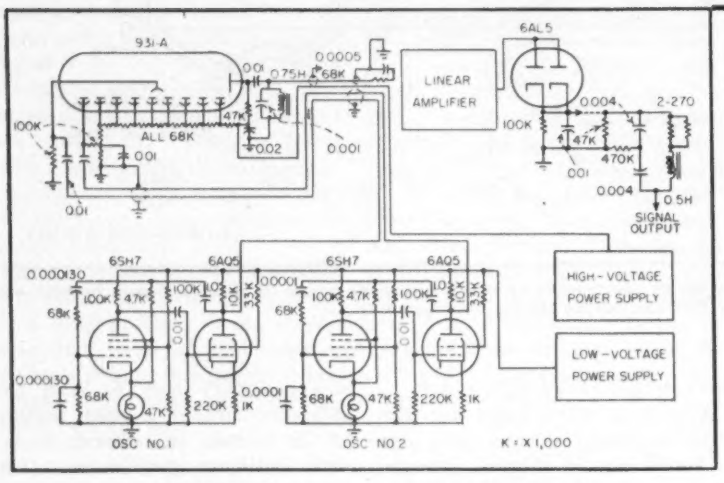


FIG. 1—Block-schematic diagram of the signal converter

RECORDING SLOWLY VARIANT signals or even steady-state values concurrently with rapid fluctuations is often necessary in research projects to obtain an accurate representation of the instantaneous behavior of a certain factor.

In biophysical research such information is contained frequently in the intensity modulation of small light sources. A multiplier phototube is generally used to convert these light fluctuations to a varying current. Conventionally these current variations have been amplified by d-c amplifiers. The low sensitivity and zero-drift problems of d-c amplifiers in this application have been circumvented by interrupting the light beam with a mechanical chopper and using a-c amplifiers but it is difficult to attain a wide bandwidth with a mechanical chopper.

Signal Converter

The multiplier phototube may be used in a heterodyne-type circuit to avoid use of mechanical choppers and to obtain bandwidths extending from d-c to kilocycles. The principle of operation is illustrated in the circuit of Fig. 1.

In addition to the d-c dynode voltages applied to the multiplier phototube, two a-c voltages differing in frequency are injected into the photocathode and first dynode respectively. These voltages cause the collection efficiency and amplification of the tube to vary as the time function of their instantaneous sum. Anode current is thus a function of light incident on the photocathode and the gain variation of the electron multiplier.

The signal contains the original frequencies as well as the sum and difference frequencies. The difference frequency is utilized as the carrier and is amplitude modulated in accordance with the light intensity.

Bandwidth Considerations

The filter at the anode of the phototube consists of a simple parallel-resonant capacitor and high-Q toroid inductor in conjunction with an R-C leg to furnish greater high-frequency attenuation. Selection of circuit Q is governed by bandwidth considerations for the signal amplification channel.

The difference-frequency carrier is amplified in a fixed-frequency amplifier. It is desirable to make the response characteristic of the amplifier as flat as possible within a bandwidth compatible with overall frequency response and amplifier noise requirements. It is also desirable to establish the low-frequency cutoff point at a value greater than 120 cps to allow freedom from line frequency pickup. The upper frequency cutoff point is less than the lower of the two oscillator frequencies, assuring good refection ratios for those voltages.

A diode detector with R-C load re-establishes the signal with the carrier-frequency ripple superimposed upon it. In general, the difference frequency is much higher than the upper cutoff frequency of the desired signal transmission band and a simple R-C diode load thus furnishes very little distortion. In the event that the difference frequency is low compared to the bandwidth, a ripple rejection filter on the output is desirable.

The choice of the oscillator frequencies is also dependent upon the desired signal-channel bandwidth in that it determines how high the Q of the input filter can be and still give satisfactory rejection to the oscillator frequencies. It is also feasible in multistage and feedback amplifiers to shape the frequency-response characteristic sufficiently to provide satisfactory rejection ratios.

The light detector is contained in a light-tight pickup unit connected by cable to the power supply and amplifier chassis. The amplifier is located as far as possible from the oscillators to minimize stray voltage amplification which in effect raises the lower limit of sensitivity of the signal converter.

This circuit operates with the phototube high-voltage positive off

Signal Converter

Intensity modulation of small light sources is converted to alternating voltage by use of a multiplier phototube giving bandwidth from zero cycles into the kilocycle region. Bandwidth is greater than that obtainable with mechanical choppers

ground to allow the oscillator injection capacitors and wiring to be conveniently electrostatically shielded from the anode circuit. The parallel-resonant circuit is located in the pickup so that the inductor will not pick up any stray magnetic fields of power transformers in the main chassis.

The oscillators are the familiar Wien bridge R-C feedback type and may be constructed side-by-side without shielding with no interaction although the oscillator voltages to the pickup must be fed through shielded conductors within the cable. It is desirable to regulate the B voltage applied to the oscillators to provide positive assurance that the oscillator voltage amplitude can be held constant by the range of compensation of the pilot-light variable-resistance element. The oscillator relative frequencies were chosen to match the highest Q of the inductor and, in this instance, provide a large enough bandwidth.

Performance Characteristics

The mechanism of the carrier modulation for low light levels is shown graphically in Fig. 2 by the envelope patterns taken from the phototube anode. The envelope repetition rate is 5,000 cps. The first pattern, created with no incident light, is representative of the interference of two oscillator voltages due to shunt capacitance formed by the proximity of pins in the cable connectors, tube bases and other circuit configurations. Effect of this stray pickup is to cause a slight nonlinearity in the variation of the d-c component of the complex envelope as shown by the other patterns.

The peak-to-peak amplitude of the waveforms maintains a linear relationship with the light input but the output of the peak-reading half-wave detector shows a deviation from the linear characteristic. The deviation is really a change in slope and it is equally valid to utilize the linear portions on either side of the knee of the curve which occurs at 1.1 microlumens. The higher light-level portion may be utilized by employing a base light, or small constant light source, within the light field to furnish a residual output just beyond the knee.

Envelope Patterns

The waveforms of Fig. 2 were taken from the signal converter used as the pickup device for an electrokymograph design used with a constant-potential x-ray machine. The bandwidth requirement of this electrokymograph, d-c to 2,000 cps is easily obtained. The frequency response was determined by mechanically interrupting the light from a d-c light source with a variable-speed motor-driven disk with 200 radial slits along its periphery. The peak-to-peak amplitude of the signal at the anode of the tube shows no frequency dependence in this range. The use of a bridged-T five-kilocycle filter to eliminate the ripple results in the amplitude decrease with increasing frequency.

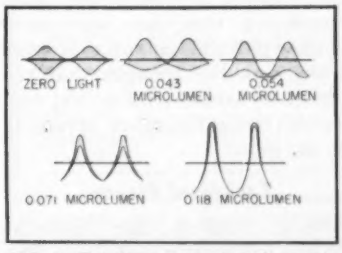


FIG. 2—Envelope patterns at the anode of the multiplier phototube

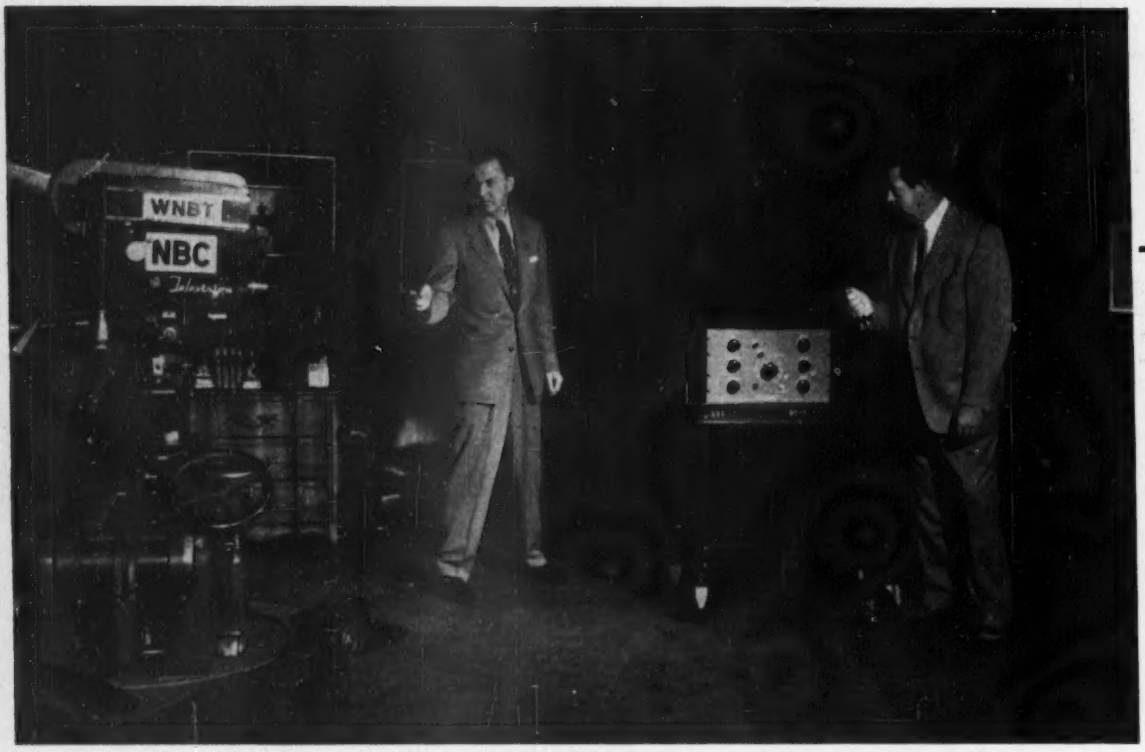
Rejection of the oscillator frequencies of 15 to 20 kc is at least 3,500 to 1 at the output of the phototube anode filter and 15,000 to 1 at the grid of the first amplifier. With an operating voltage of 700 volts on a 931-A phototube, the overall signal-to-noise ratio is 40 with an anode current of 10 microamperes. The noise component due to the random phase shift of the oscillators is the equivalent of a signal-to-noise ratio of 65 under the same conditions. This phase-shift noise is approximately 15 times larger than the dark-current noise of the phototube itself.

Stability of the system is essentially that of the multiplier phototube high-voltage supply which should have regulation better than 0.001 percent for each percent change in line voltage and comparable long-time stability. After a 15-minute warm-up time for the oscillators and the carrier amplifier, the sensitivity drift is 0.03 percent per hour.

This system is applicable not only to measurements involving light measurements directly but also to problems where the conversion of the signal information to light may be accomplished efficiently with fidelity. Not only does the multiplier phototube add its inherent high-gain advantages but the signal information may be amplified and handled in a high-level mode in the carrier amplifier with complete freedom from 60-cycle pickup and line hash.

The greatest single advantage of this converter is that it offers an all-electronic method of obtaining high-fidelity amplification of signals requiring a wide bandwidth including d-c.

Gunshot Generator



Method of using gunshot generator during television drama. Engineer at right holds single-shot pushbutton in hand and presses it when television detective Martin Kane pulls trigger of unloaded gun

By J. L. HATHAWAY and R. E. LAFFERTY

Engineering Development
National Broadcasting Co., Inc.,
New York, N. Y.

IN A LARGE Radio City studio, television detective Martin Kane faces this week's criminal. Millions of viewers expectantly wait for the story to reach its climax. Suddenly Kane whips out his pistol and pulls the trigger . . . ptzz. The exposion has all the roar of a wet cap.

This is certainly not the climax the director of the show expected, nor does it conform with the thoughts of the audience. For most viewers, twenty-five minutes of drama is forgotten for a few seconds of humor. It is not funny, however, to television broadcasters. Breaking the continuity of a dramatic story with unscheduled comedy is disastrous.

Why did the shot fail? An investigation by the Engineering Development Group of the National Broadcasting Company has disclosed a multitude of possible reasons. In some instances the fault was not at all technical but simply a case of fright. Some actors, and a few actresses, have complained that as they were about to pull the trigger, they were seized with the thought that the pistol was loaded with actual bullets and were therefore afraid to fire the gun.

Technical Fizzes

Other reasons for gunshot failures are mostly technical. The mechanical condition of the gun and particularly the firing pin, the cap, the type of powder and the loading in the cartridge all contribute to the quality of the report. The condition of a gun can be checked prior to its use, but unfortunately, the only satisfactory test for a blank cartridge results in its destruction. Efforts, therefore, were directed toward a more reliable powder, and for reasons that will be discussed later, a longer burning powder. This approach resulted in the selection of large-caliber cartridges for desirable burning characteristics and reliability. Reports from pistols using these special blanks were so loud, however, that many actors refused to use them. Even

for Television Studios

Guns loaded with blank cartridges sound unreal, occasionally misfire and often scare performers in acoustically dead television drama studios. To offset this, a new electronic unit automatically reinforces weak shots or generates the entire sound effect for revolver, machine-gun and cannon fire, as well as ricochet effects

these cartridges occasionally misfired and moreover, there seemed to be little correlation between the loudness of the report within the studio and that of the reproduced sound.

It is axiomatic in both the broadcasting and motion-picture fields that loud studio shots do not necessarily produce loud sounds for the ultimate listener. In any medium where the amplitude must be controlled to prevent an overload of the system, high-intensity sound of extremely short duration is heard, when reproduced, as low-intensity sound of short duration. In such systems of limited volume range, the apparent loudness can be increased only by increasing the duration of the sound. Thus, long-burning powders of medium intensity reproduce louder than high-intensity, short-burning powders after both reports are transmitted through a broadcasting system.

Need for Reverberation

Still another problem, peculiar to the medium of television, is the special acoustical treatment required in the studios. In other studios, such as those for radio broadcasting, tape or disc recording, or motion-picture sound, extraneous noise can be minimized during the actual production and excessive reverberation of speech avoided by reducing the microphone working distance.

In television, quite large microphone distances are frequently unavoidable. Furthermore, the desired sound must compete with considerable background noise. The combined motion of actors and actresses to and from stage sets, stagehands with scenery and props, dolly pushers moving cameras and microphone booms, lighting men, floor managers and many others makes for a relatively high ambient noise level.

The television broadcaster must combat background noise with directional microphones and acoustical absorbing materials located on the studio walls and ceiling. By radio broadcasting standards, the result is a dead studio. Reverberation would allow gunshots to persist and increase their apparent loudness. The lack of it, coupled with amplitude restriction of the audio system, is deleterious to realistic gunshot reproduction.

As a possible remedy for the anemic shot reproductions, a small reverberation chamber was constructed. The large chambers which are normally used for special effects with speech and music were tried for this purpose with considerable success, but the demand for these on other effects was so great that programs involving gunplay were unable to depend on their availability.

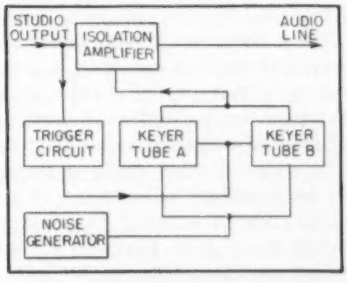


FIG. 1—Block diagram showing portion of generator used to furnish reverberation to gunshot by inserting a decaying random-noise signal after the actual shot signal

Although considerable attention was given to the elimination of pronounced resonant effects in the small chamber, several objectional peaks in the medium-frequency region were evident while at other frequencies the reverberation time was insufficient. These defects forced a new approach which resulted in the design and construction of an electronic shot reinforcer and shot effects generator.

Gunshot Reinforcer

A study of various pistol shots showed the sound of a shot to be largely a function of the bore and length of the gun barrel, the nature of the powder and its burning rate and the loading of the cartridge. The wave envelopes of most shots, however, have steep fronts and trailing edges that decay slowly. The acoustical energy within the envelope is generally heterogeneous, and in this respect resembles noise. Further investigation proved that noise, properly controlled, could be made to simulate a pistol shot effectively.

The first use of this principle was in a reinforcer unit in combination with an actual gunshot. Because it is the reverberation of the shot that is insufficient in television studios, the arangement of Fig. 1 was designed to insert a decaying random-noise signal automatically after the actual pistol shot. This equipment has been successfully used for some time, and several additional units have

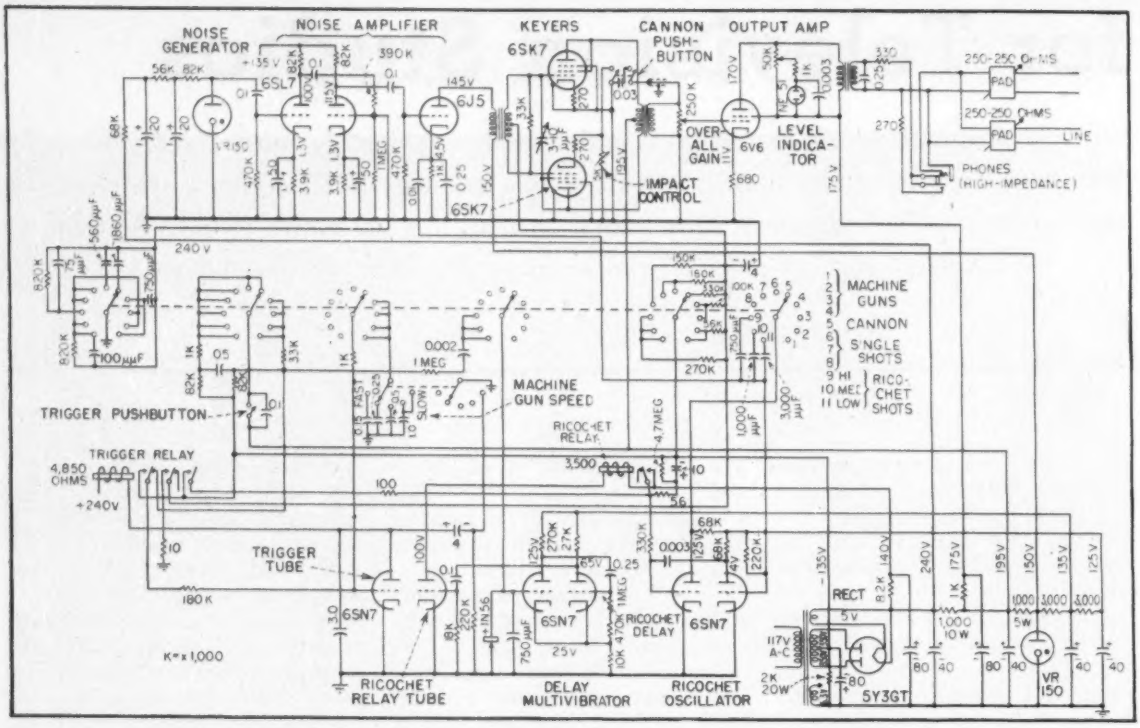


FIG. 2—Complete circuit diagram of gunshot generator, with all values of components indicated

been installed in various locations.

The gun shot reinforcer is inserted in the outgoing line of a studio prior to the start of the program and carries the entire audio output of the studio. It is level-actuated and hence completely automatic in its operation. When a gun is fired in the studio, the trigger tube actuates a relay, which removes the excessive bias from a pair of push-pull amplifier tubes normally held at cutoff. The output of a noise generator, after filtering, is continuously applied to the grids of these same amplifier tubes.

After the keyer tubes are pulsed into operation they are slowly returned to the cutoff state. The reproduced effect of the sudden noise pulse with a slow decay is essentially that of a gunshot. If the push-pull keyer tubes are purposely unbalanced to a slight degree, the d-c thump component when the bias is suddenly removed produces an impact with the shot to further enhance its realism.

The trigger tube and circuit design are such that, assuming a fixed gain adjustment, extremely loud sounds with steep wave fronts cause the reinforcer to fire, whereas shouts and screams only a foot from the microphone do not.

Gunshot Generator

The steps from an automatically triggered shot reinforcer to a versatile manually operated shot generator were fairly obvious. The level-acutated trigger circuit was first replaced by a pushbutton. Unbalanced keyer tubes gave the synthetic shot an initial impact followed by the decaying noise to simulate the effect of reverberation. The length of the shot is controlled by varying the recovery time of the keyer tubes. These are normally held at cutoff by a large negative voltage, fed to the grids through an R-C filter consisting of a 4.0-μf capacitor and a resistor. The value of this resistor serves as an excellent adjustment of recovery time. Actually the rate of noise decay is a function of the cutoff characteristic of the keyer tubes and several other factors. Constants are so chosen as to produce essentially a logarithmic decay of sound output.

The characteristics of shots may be altered by another factor, namely the frequency response of the noise amplifiers preceding and following the keying. If the high-frequency components of the noise are attenuated and the length of the shot increased, large-caliber arms can be simulated. Carried to an extreme, the effect of distant cannon fire can be realistically produced.

Machine-Gun Simulation

Once single shots are generated, an additional possibility becomes apparent. When the trigger button is pushed a number of times in quick succession, an excellent machine-gun effect results. The requirement of manual dexterity can be eliminated from the operation by using a low-frequency oscillator to trigger the shots repeatedly. The rate of fire is adjustable by varying the frequency of this oscillator. When a variable-bandwidth filter in the noise amplifier is simultaneously adjusted, a number of machine gun effects are readily obtained, ranging from a light-weight 0.45-caliber machine

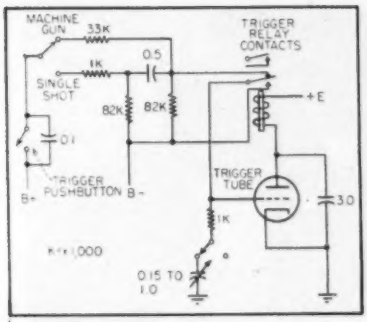


FIG. 3—Circuit used to obtain either single-shot effect or machine-gun sounds

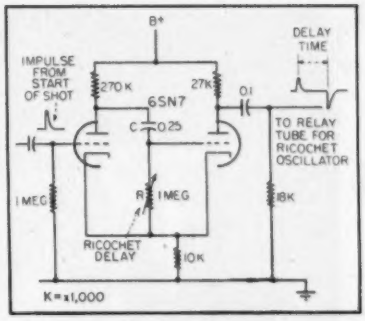


FIG. 4—Delay multivibrator circuit in simplified form, with pulse waveform

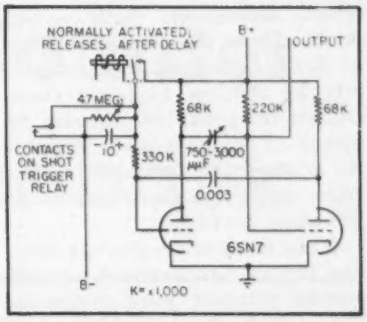


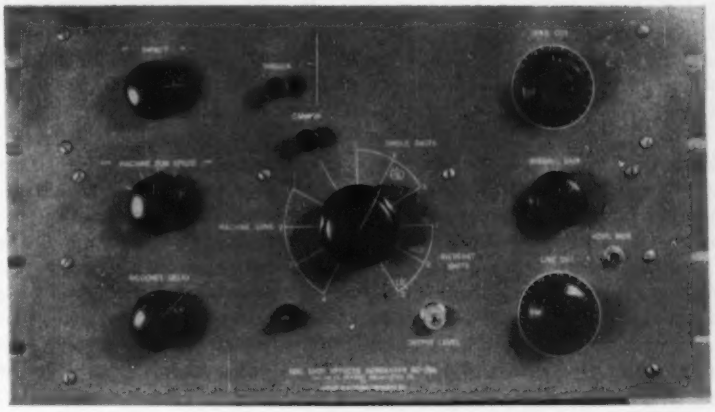
FIG. 5—Ricochet delay relay circuit and associated double-triode oscillator

gun (tommy gun) to a large 40-mm anti-aircraft gun (pom-pom gun). Thus, a master switch is provided to select the shot length and also establish the bandpass characteristic of the noise amplifier. Fewer high-frequency noise components are amplified when the length of the shot is increased. This conforms with the character of natural reverberation where the high frequencies are quickly attenuated by air, making the reverberation principally a medium and low-frequency phenomenon.

Because the controls for the rate of machine-gun fire and shot length are independent, a variety of effects is possible. Experience has shown, however, that some combinations are anomalous. The rapid chatter of a Thompson submachine gun, for example, is out of place with the roar of a 40-mm anti-aircraft gun.

Ricochet Effect

A further embellishment which increases the flexibility of the shot effects generator is a ricochet effect. This is accomplished with a free-running resistance-capacitance oscillator which generates a harsh whine. The sequence of events is as follows: A shot with long decay time is generated in a normal manner, while at the same time a pulse initiates a single-cycle delay multivibrator. At the completion of the cycle the ricochet oscillator is activated through a mechanical relay and its output mixed with the decaying noise of the shot. The overall effect is a loud report with reverberation, then, after a short delay, a whine of decreasing frequency and amplitude. A control is provided to adjust the delay before the start of the ricochet from about 0.1 to 0.75 second.



Front-panel controls of generator permit quick setting to give variety of shot effects

An interesting point developed concerning the whine of a ricocheted bullet. This whine is generally produced by a bullet that wobbles irregularly or spins end-over-end in its flight after striking, but not entering, a solid object. The frequency variation of the whine depends on Doppler effect as well as the changing rate of spin. Marksmen agree that the pitch may increase at first, then decrease, or it may steadily decrease. The average person, however, has only heard ricochets through the medium of motion pictures. A survey of several films indicates that only one type of ricochet whine has been used extensively—the gradually decreasing pitch.

It was apparent, after a brief listening test, that the movies have educated us to accept this ricochet. Rather than oppose public opinion, the shot-effects generator was designed to conform with the accepted version. To provide some variety, ricochets of three different pitches may be selected.

Complete Circuit

A few refinements were incorporated in the final design, shown in Fig. 2. For example, functions are preset with the master switch and only one pushbutton is required to fire the shots. Thus a remote pushbutton can be used to trigger from a distant point in the studio if desired. Operating errors are minimized in equipment which can be preset, as opposed to equipment in which several switches must be thrown at a critical time. An overall volume control is provided as well as separate faders for feeding the line and speaker.

To permit headset monitoring and last-minute selection and adjustment, a phone jack is provided

which disconnects both output feeds. Thus, the control settings as well as overall performance may be checked during a show. Output level may be adjusted by means of the neon-tube indicator if necessary. Maximum output from each channel is +8vu at 250 ohms impedance.

While many of the circuits function in a straight-forward manner, several warrant some attention. For example, the desirable feature of a single pushbutton was achieved with the relatively simple circuit of Fig. 3. With this, when single shots are needed, a master switch connects a resistance-capacitance coupling network between the pushbutton and the trigger circuit.

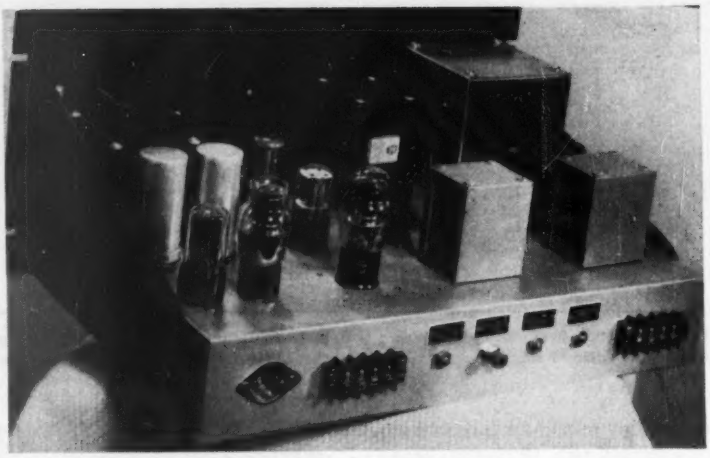
When the button is pressed, a single voltage pulse of positive polarity is fed through normally closed contacts on the trigger relay to the grid of the relay tube. This positive pulse causes a surge of current to flow through the tube and relay, energizing the latter. This action results, by way of the make contacts, in the application of a large negative voltage on the grid which returns the tube and relay to the normal state.

Unless the grid receives another pulse of positive voltage, the tube remains in this condition. Holding the button down after firing a single shot does not produce additional shots by virtue of the resistance-capacitance coupling network.

If the action in the studio calls for a machine-gun effect, the master switch on the shot-effect generator is positioned to connect the positive voltage through the pushbutton and a resistive network to the grid of the relay tube. Consequently, this tube, in conjunction with the relay, oscillates as long as the pushbutton is depressed since there is no capacitor in series with the positive source of voltage as in the case of the single-shot circuit. The frequency of oscillation is determined by a combination of resistance and capacitance in the grid circuit of the relay tube.

Delay Circuits

Consider now the ricochet effect, where for realism, a short delay must exist between the shot and the start of the whine. The circuitry consists of a single-shot multivibrator which accomplishes the delay, plus a relay tube and relay that turns on the ricochet oscillator to produce the actual whine.



Rear of generator, showing the four preset controls for shot amplitude, trigger adjust, keyer balance and amplifier gain

The delay portion of the shot-effects generator is shown in simplified schematic form in Fig. 4. The d-c positive pulse that initiates the shot is also coupled to the first grid of the delay multivibrator. The plate of this tube then feeds a negative pulse to the second grid, cutting it off. The delay time is equal to the time this tube remains at cutoff and is a function of the time constant, RC. When C discharges sufficently to bring the second grid into the conduction region, the cycle is completed and this tube is snapped into heavy conduction. By virtue of the interconnection of the cathodes, the first tube is then returned to its normal condition of cutoff, completing the cycle with a large negative swing at the second plate. This pulse is partially differentiated by the coupling network and fed to the grid of the relay tube, causing it to release the relay momentarily.

Fig. 5 shows the ricochet delay relay and the oscillator which it activates. A high negative bias on the first grid of this resistance-capacitance oscillator maintains it normally inactive. When the relay momentarily opens, however, the 10-μf capacitor is positively charged, causing oscillations to start. Frequency is a function of the magnitude of voltage applied to the grid. As the capacitor discharges, the pitch decreases. The output of this oscillator is mixed with the synthetic reverberation of the shot and the amplitudes of both signals decay logarithmically through the keyer tubes.

Because the ricochet oscillator continues to function until the voltage on the 10-μf capacitor drops below ground potential, a means is provided to discharge this capacitor quickly, permitting other ricochet shots to follow in rapid sequence. Otherwise, during the delay period between the second shot and its ricochet, low-pitched oscillations remaining from the previous shot would be heard. A pair of open contacts on the triggering relay is therefore connected across this capacitor. Each time a shot is fired, these contacts close to discharge the capacitor quickly.

Principles learned during the development of these instruments, coupled with a little imagination, point the way to the creation of many electronic sound effects. The only limitations would appear to be those imposed by size and cost. Present knowledge makes feasible such effects as distant thunder, large or small bells, wind and waves, sirens, screaming shells, creaking doors or wheels, audience applause and many other similar effects.

Gated Decade Counter Requires No Feedback

Combining convenience of decade system with reliability of binary, gated decade counter uses electronically-switched gate instead of critical clamping and feedback networks. Bias range is same as for binary system. Resolution is limited only by resolution of binaries

By E. L. KEMP
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

VARIOUS COMPUTER and counter systems make use of the Eccles-Jordan binary circuit as a pulse divider. Since a scale of two is not compatible with the decimal system, feedback is often used to convert the normal binary sequence to a decade. Typical decade systems using feedback are: the Potter decade[1] and the sixteen-minus-six decade.[2] In both systems, use of feedback makes the decade bias range less than the bias range of a binary system using no feedback. The gated decade overcomes this disadvantage by using a switched gate.

General Description

Bias range for this decade is the same as the bias range of a binary system. This type of decade has no critical clamping or feedback networks. It depends solely upon the binary operation of the circuit to accomplish the permutation of binary to decade counting. Resolution of the system is limited only by the resolution of the binaries. The gated decade lends itself inherently to four-light interpolation; it has been used successfully in a nuclear scaler and is adaptable to any type of counting.

The gated decade contains five stages. The decade divides by sending eight pulses into one storage system and two pulses into another, then resetting. Eccles-Jordan binaries are used as storage devices. An electric-switch-type gate circuit is used to control the direction of pulse flow through the decade.

Figure 1 is a block diagram of the gated decade. The first eight pulses go into the first binary, the gated amplifier and the second and third binaries. The eighth pulse activates the gate so that the ninth and tenth pulses go into the second system consisting of the gated amplifier and the gate-control binary. The tenth pulse resets the decade. The output from the gated decade is taken from the gate-control binary.

Gate Operation

The gate controlling the direction of pulse flow through the decade uses two tubes as shown in Fig. 2. One tube is used as an amplifier and the other as an Eccles-Jordan binary. The action of the gate may be best understood by reviewing briefly the operation of the binary circuit. It is a characteristic of

TAXPAYERS' DIVIDEND

Vast sums spent for atomic weapons development forge a vital link in our national defense. An additional payoff for the engineer comes in the form of equipment and techniques developed in atomic research that are useful in many diverse fields.

Introduced in a nuclear scaler used at Los Alamos, this improved counting circuit is adaptable to any type of counting operation

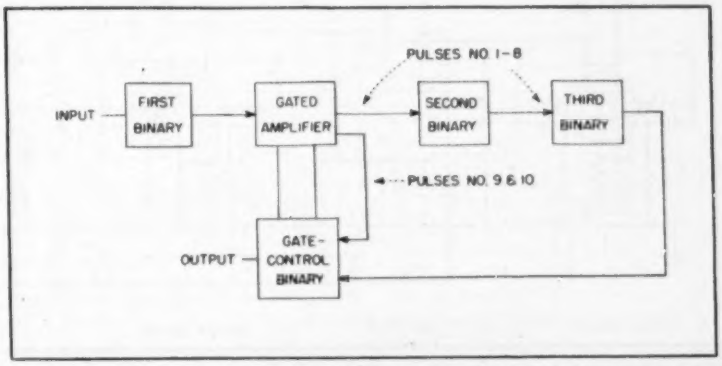
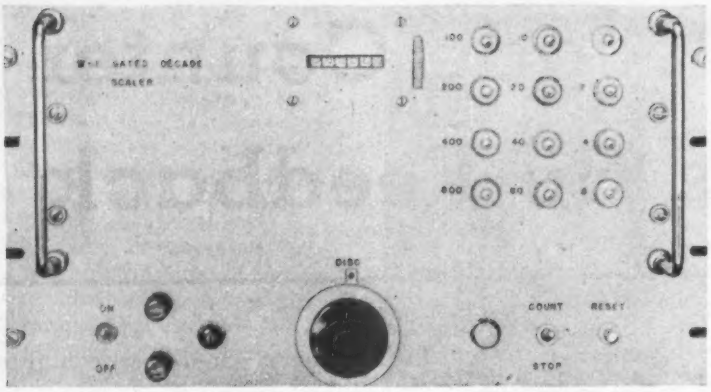


FIG. 1—Decade counter uses electronically-switched gate. Eighth input pulse trips gate; tenth pulse resets counter



Nuclear scaler using gated decade has set record for reliable operation

this circuit that the grid of the conducting plate is at cathode potential or zero bias. Conversely, the grid of the nonconducting plate is beyond cutoff. When the binary is flipped, the grids reverse their potentials. A binary can be flipped with negative input pulses.

Figure 2 shows the grids of the gated amplifier fed in parallel. It should be noted also that they are returned through isolating resistors to grids of the gate-control binary. Thus the conducting plate of the amplifier corresponds to the conducting plate of the gate-control binary. The other plate of the amplifier is likewise cut off corresponding to the state of the binary. A pulse entering the gated amplifier may be passed in the direction dictated by the state of the gate-control binary.

The cathode bias for the gate tubes may be taken from a cathode resistor as shown in Fig. 2. The dotted lines in Fig. 2 indicate an alternative bias scheme, which uses a negative supply for biasing the grids of the gate. Figure 3 illustrates the negative supply method.

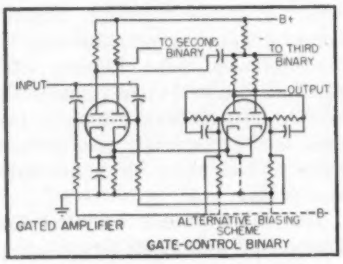


FIG. 2—Gated amplifier with paralleled grids is switched by gate-control binary

A schematic drawing of the gated decade is shown in Fig. 3. All the binaries are capacitor-coupled through common plate impedances. C_d and R_d form a differentiating network between the first binary and the gated amplifier and the subsequent binaries.

Circuit Description

There is a crystal diode in series with the coupling capacitor from the third binary to the gate-control binary. The action of this diode is to prevent the output from plate *A* of the gated amplifier from feeding into the third binary. The output of the gated decade is taken from a plate of the gate-control binary.

The operation of the gated decade may be better understood by following pulses through the circuit. The plate waveforms shown in Fig. 4 refer to the labeled stages in the schematic drawing.

The input pulses are converted into square waves by the first binary. These square waves are differentiated by C_d and R_d and fed into both grids of the gated amplifier. Plate *B* of the amplifier inverts the positive input pulses and feeds them into the second binary and subsequently into the third. The eighth pulse causes the third binary to send out a negative pulse which flips the gate-control binary. The ninth pulse is negative when

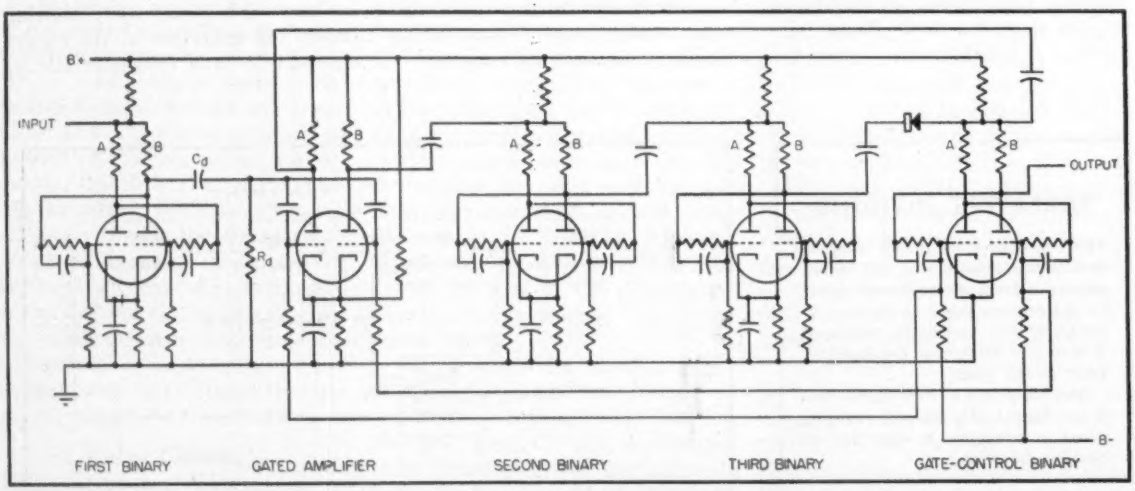


FIG. 3—Counting operation may be traced from circuit schematic. Eighth pulse flips third binary, which, in turn, flips gate-control binary. Gated amplifier feeds tenth pulse to gate-control binary resetting decade and producing output pulse

entering the gated amplifier, so it is rejected. The tenth pulse which is positive is inverted by the amplifier and fed into the gate-control binary which then flips back and resets the decade. The output to drive another decade is taken from plate *B* of the gate-control binary.

It should be observed from the waveforms that the gate-control binary and the gated amplifier have the time from the end of pulse eight to the start of pulse ten in which to be reset. This is also true for the time between pulse ten and pulse two. The resolution time of the decade can therefore be as fast as the resolution time for the first binary if care is used to design the gate-control binary with a resolution no more than twice the resolution time for the first binary.

Nuclear Scaler

The gated decade circuit has been used successfully in the scaler shown in the photograph to count particles in radioactive decay. The familiar four-light interpolation scheme was used. Figure 5 shows the schematic of the scaler.

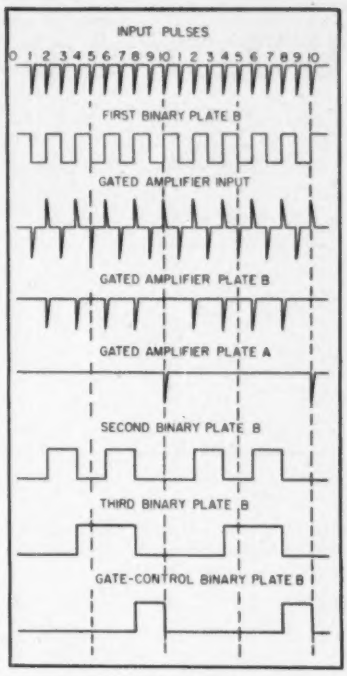

INPUT PULSES
0 1 2 3 4 5 6 7 8 9 10 1 2 3 4 5 6 7 8 9 10
FIRST BINARY PLATE B
GATED AMPLIFIER INPUT
GATED AMPLIFIER PLATE B
GATED AMPLIFIER PLATE A
SECOND BINARY PLATE B
THIRD BINARY PLATE B
GATE-CONTROL BINARY PLATE B

FIG. 4—Plate waveforms

The scaler contains a regulated power supply, a discriminator, three decades and a mechanical register. The scaling factor is 1,000. The resolution of the instrument is two microseconds. The discrimination range is from 10 volts input to 100 volts. The maximum counting speed, which is set by the register, is 700,000 counts per minute. The power supply is regulated and delivers 125 ma plate current for the whole instrument. The instrument has been extremely reliable, giving satisfactory performance for as long a period as three months of 24-hour daily operation.

References

(1) J. T. Potter, Electronics, p 110, June 1944.
(2) I. E. Grossdoff, *R.C.A. Rev* 7, p 428, 1946.

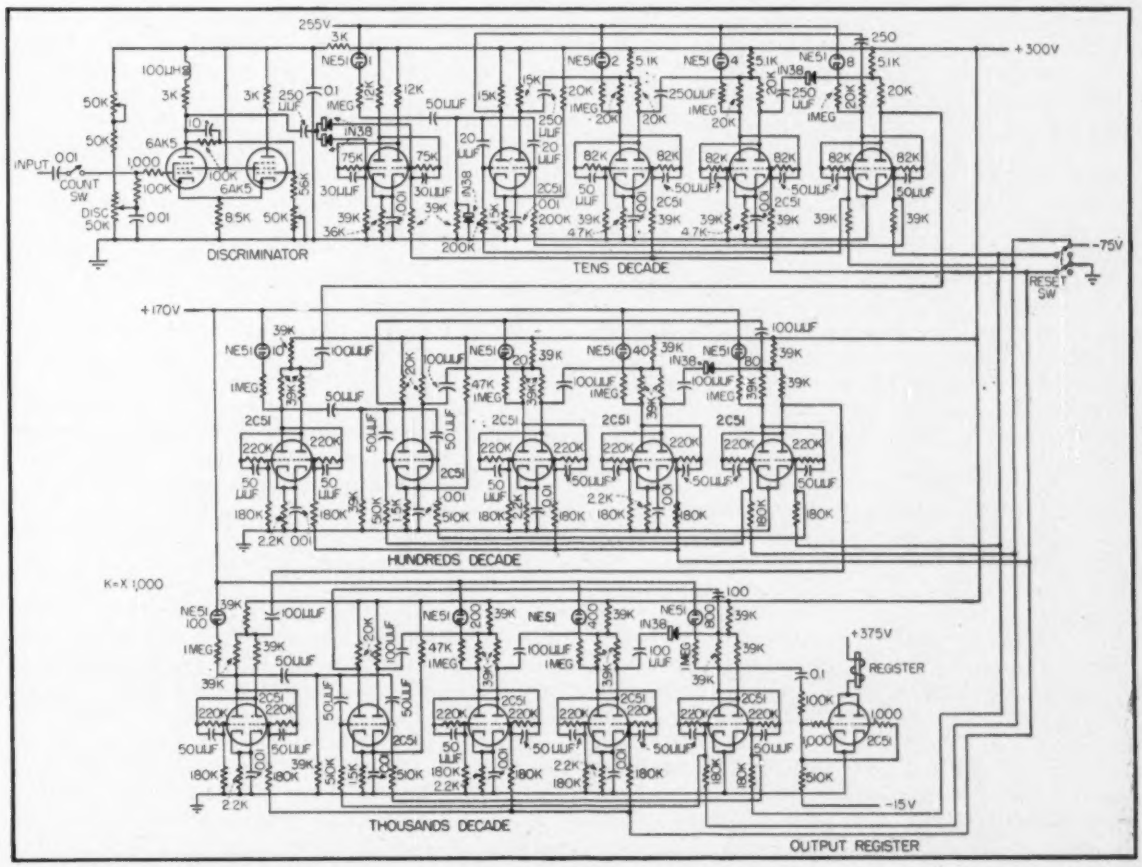


FIG. 5—Nuclear scaler uses input discriminator and three gated decades to count particles in radioactive decay. Four-light interpolation is used

Vacuum-Tube T-Pad

By ED C. MILLER
Chief Engineer
N. R. C. S.
Weiser, Idaho

IN A T-pad, such as is illustrated in Fig. 1A, it is possible to make R_1 equal to the input impedance and R_2 equal to the output impedance, if the loss of the pad is greater than 20 db. This approximation is permissible since the calculated values of these resistors so nearly approach (but never quite equal) their respective impedances.

It is then possible to calculate the maximum value of R for a loss of 20 db and, by varying this resistance from zero ohms to the calculated maximum, to produce an attenuation of any amount from infinity to 20 db with one variable element.

In the electronic attenuator circuit to be described, R is replaced by the plate-to-cathode resistance of a vacuum tube, and attenuation is controlled by changing its positive d-c grid voltage. The characteristics of most low-power triodes are such that with proper plate voltage, an approximately logarithmic change in plate current, and therefore plate resistance, is produced by a linear change in positive grid voltage.

Figure 1B illustrates the basic circuit with the addition of a rectifier to provide a grid voltage corresponding in amplitude to the a-c signal. Because of the logarithmic change in plate resistance caused by a linear change in grid voltage, the output of Fig. 1B will be constant, though the input changes appreciably.

Limitations

At first look it would appear that the range of input changes for which constant output would be maintained would be unlimited. There are limits, however.

On one hand, because R and R_2 are in parallel as regards the a-c signal, the ratio of R_2 to R (at minimum attenuation of 20 db) must be at least 10 to 1. On the other hand, the plate current fails to increase in log fashion when the plate voltage approaches the value of the d-c grid voltage. The range available with a 6J5 triode is about 20 db.

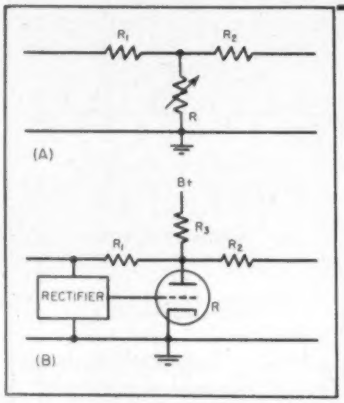


FIG. 1—Replacing it with signal-biased vacuum tube provides signal compression

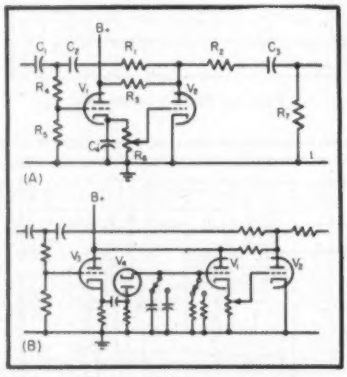


FIG. 2—More elaborate circuits prohibit distortion by input loading and extend frequency response

Grid current is drawn by the limiting tube because the grid voltage increases in a positive direction with increasing input signal. If this changing current were supplied by the a-c signal, distortion would result. In Fig. 2A, the grid voltage is supplied by the d-c plate supply, but is proportional to the signal level. To further insure that the input will not be loaded, the grid of the cathode-follower-rectifier V_1 is attached to a voltage divider, instead of directly to the input. Capacitors C_1, C_2 and C_3 are merely isolating capacitors, and C_4 filters the rectified signal.

Adjustment of the zero compression point for individual tubes may be done by making R_1 equal to 10 times the plate-to-cathode resistance of V_2, with the grid of V_2 connected to the cathode of V_1, and by making R_2 equal to R_1. A simpler way is to use equal fixed values for these resistors and to adjust the grid voltage of V_2 to the point where the plate-to-cathode resistance is 10 percent of R_1. This can be done with R_6. In practice R_6 can be set to give a reading of 10 percent of the plate supply voltage, as measured with a vtvm at the plate of V_2 with no signal applied.

Frequency Response

The frequency response of this circuit is limited on the high end by the plate-to-cathode capacitance, and on the low end by the time constant of C_4R_6 and the grid-to-cathode resistance. With C_4 chosen to give sufficiently rapid compression and sufficiently long release for speech, the response is flat from several hundred kc down to 100 cycles with rising distortion below 200 cycles.

Where better low-frequency response and variable compression and release are desired, the circuit of Fig. 2B may be used. The lowest frequency of this design is limited by the d-c transient produced by sudden input amplitude fluctuations.

By using a remote-cutoff pentode as the first succeeding amplifier and operating it at fairly high bias, these transients will not adversely affect the overall performance. If frequencies below 200 cycles are not desired, as in communications work, the time constants of $C_1(R_4 + R_5)$ and C_2R_7 of Fig. 2A, should be short enough to attenuate the lower frequencies. Tubes that have proved satisfactory for V_2 are the 6J5, 6C5, 6SL7, 6SN7, 6SQ7, 6SF5 and 6SC7.

For the satisfactory operation

Logarithmic Attenuator

Circuit provides basis for communications-type speech compressor using vacuum tube in leg of T-pad to limit speech peaks logarithmically and provide high percentage of modulation for a-m transmitter. Complete modulator is described

of any volume compressing unit, there must be an input amplitude up to which no compression takes place. If this were not so, the output would be held at zero. In the present circuit V_1 performs this function along with controlling the grid voltage to V_2. The cathode bias supplied by R_6 can not completely cut off current flow in V_1. Until the negative half-cycle of the applied signal is of sufficient intensity to cause cutoff when added to the cathode bias, the d-c voltages at the top of R_6 and at the grid of V_2 will remain unchanged. After this level is exceeded, the cathode voltage will follow, in a nearly linear manner, the signal amplitude.

Operating Conditions

Plate supply voltage is not critical, and if V_1 and V_2 are supplied from the same source the voltage may vary from 150 to 500 volts. It should be remembered that an attenuator introduces a loss in the circuit to which it is connected. This loss varies from 20 db at no compression to 40 db at maximum compression. The 20-db loss can easily be regained by the addition of a single stage of amplification following the compressor.

The signal level at which logarithmic compression takes place will vary with different tubes. For a 6SL7GT, used for V_3 and V_2, compression will begin at about three volts rms at the input.

This volume limiting circuit has many applications in various audio circuits, but its simple construction, easy adjustment and low cost readily adapt it to use at a low-level point in a speech amplifier for modulating a communications transmitter.

Figure 3 shows the schematic of a modulator using the circuit. It was designed to supply about 50 watts output with 700 volts plate supply to the class B tubes.

The high-impedance crystal communications microphone output is amplified by V_1 sufficiently to operate the electronic attenuator or limiter at up to 20-db compression without clipping. No gain control is used before the limiter because the mike output for almost any operator works into the compression level range. The only change in the limiter from that already described is the insertion of SW_1 across R_6. When this switch is open, normal limiter action takes place. Closing it shorts out the input to the high-impedance rectifier so the grid voltage on the limiter V_{2B} remains at the value for zero compression, that is, a fixed attenuation of 20 db. This switch allows the modulator to be used with or without compression. Pentode V_3 is used to compensate for the 20 db loss inserted by V_2. A 6SJ7 with the values shown does this easily with enough to spare to drive a 6V6GT as a low-power power amplifier. The gain control in the grid of V_4 is used to adjust the modulation to the desired amount with the compressor in operation.

Adjustment

Adjustment is achieved by setting R_6 to make the voltage at the plate of V_{2B} equal to ten percent of that at the plate of V_{2A} as measured on a vacuum-tube voltmeter, with SW_1 closed. Then, with SW_1 open, one talks into the microphone sufficiently loud and close to cause the vtvm connected to the plate of V_{2B} never to exceed 50 percent of the voltage present when SW_1 is closed.

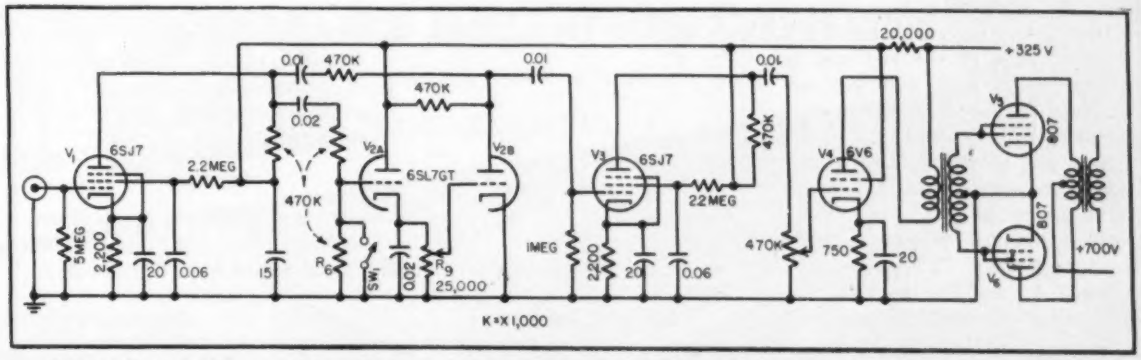


FIG. 3—Typical 50-watt modulator built around compressor circuit. Resistor R_2 (Fig. 1) can be omitted for speech work

Graphical Solution of Sky-Wave Problems

Chart shows relationship between great-circle distance, virtual height of reflection, equivalent path distance, angle of departure and angle of incidence at ionosphere so any three can be found if other two are known

By R. A. HELLIWELL

Assistant Professor
Department of Electrical Engineering
Stanford University
Stanford, California

IN RADIO communication problems involving transmission by means of sky-waves reflected from the ionosphere it is often necessary to relate: (1) great-circle distance between transmitter and receiver, (2) virtual height of reflection, (3) equivalent path distance between transmitter and receiver, (4) angle of departure, and (5) angle of incidence at the ionosphere. It is the purpose of this paper to present a simple graphical method whereby these factors can be determined rapidly without recourse to the analytical expressions. If any two factors are given, the other three can be found.

It is assumed that propagation can be represented by a ray and that the characteristics of the actual path of the ray can be represented with sufficient accuracy by the so-called equivalent path, shown in Fig. 1 as the lines *AB* and *BC*. The height *h'* of the apex *B* is called the virtual height, and *D* is the great-circle distance between the endpoints *A* and *C*. The angle β between *AB* and the tangent at *A* is called the vertical angle or angle of departure. The ionosphere is assumed to be horizontally stratified and earth's magnetic field effects are neglected. The path is therefore symmetrical about the midpoint, and the angle of arrival is equal to the angle of departure.

Graphical computations are facilitated with the aid of the sky-wave transmission chart shown in Fig. 2. This is simply a vertical cross-section of the earth's atmosphere up to a height of 600 km. Great-circle distance *D* on the earth's surface is plotted against virtual height *h'* appearing at left with the chart held sideways.

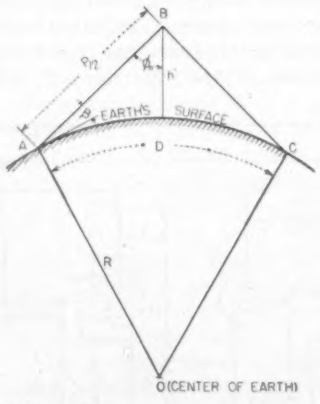


FIG. 1—Diagram shows geometry of sky-wave propagation

The vertical angle β is determined by aligning a straight edge with the origin and the midpoint of the equivalent path (co-ordinates *h'* and *D*/2) and reading the upper scale. The angle of incidence ϕ_o is interpolated in the family of curves of constant ϕ_o plotted on the chart. Secant ϕ_o is read from the conversion chart below the main chart.

Since there are five basic variables (*D*,*P*,*h'* β, and ϕ_o) only two of which can be independent, there are ten possible combinations of independent variables. For any given pair of variables, the other three are determined from the chart. The procedure is illustrated in the following example for a selected pair of variables (*D* and *h'*).

Example

Problem: Given a great-circle distance *D* of 3,000 km and a virtual height *h'* of 310 km, find the vertical angle β, the angle

(Continued on p 152)

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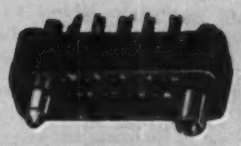

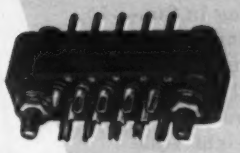

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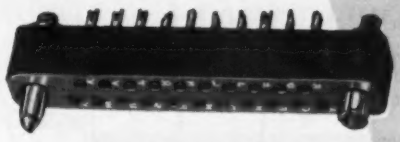

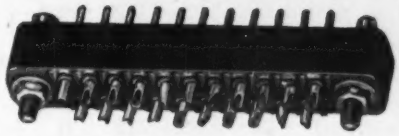

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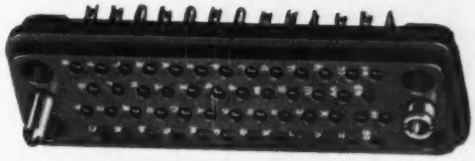

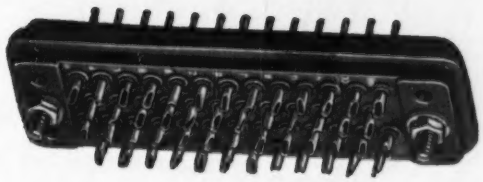

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Sky-Wave Problems (continued from p 150)

of incidence ϕ_o at the ionosphere, sec ϕ_o, the path distance P, and the transmission time t.

Solution: Locate the apex of the path at $D/2 = 1{,}500$ km and $h' = 310$ km on Fig. 2. Align straight edge with origin and apex. Read $\beta = 4.5$ degrees on the upper scale. Read $\phi_o = 72$ degrees by interpolating in family of curves of constant ϕ_o. Obtain sec $\phi_o = 3.2$ from conversion scale. Obtain $P = 3{,}140$ km by measuring distance from origin to apex, using the height scale on the chart, and multiplying result by 2. The transmission time $t = 10{,}470 \times 10^{-6}$ seconds is obtained by dividing the path distance P by the speed of light (3×10^5 km per sec).

The author wishes to acknowledge the helpful comments of A. M. Peterson.

Appendix

Some of the more important analytical expressions, based on Fig. 1, are given below for reference. Others can be derived readily.

$$\phi_o = \tan^{-1} \frac{\sin \frac{D}{2R} \frac{180}{\pi}}{1 - \cos \frac{D}{2R} \frac{180}{\pi} + \frac{h'}{R}}$$

$$\beta = 90 - \phi_o - \frac{D}{2R} \frac{180}{\pi}$$

$$h' = R \left[\frac{\cos \beta}{\cos\left(\frac{D}{2R} \frac{180}{\pi} + \beta \right)} - 1 \right]$$

$$D = 2R \left[\cos^{-1}\left(\frac{R}{R+h'} \cos \beta \right) - \frac{\pi}{180} \beta \right]$$

$$P = 2 \times \sqrt{2R(R+h')\left(1 - \cos \frac{D}{2R} \frac{180}{\pi}\right) + h'^2}$$

where D = great circle distance in km
h' = virtual height in km
P = path distance in km
β = vertical angle in degrees
ϕ_o = angle of incidence in degrees
R = earth radius (6,367 km)

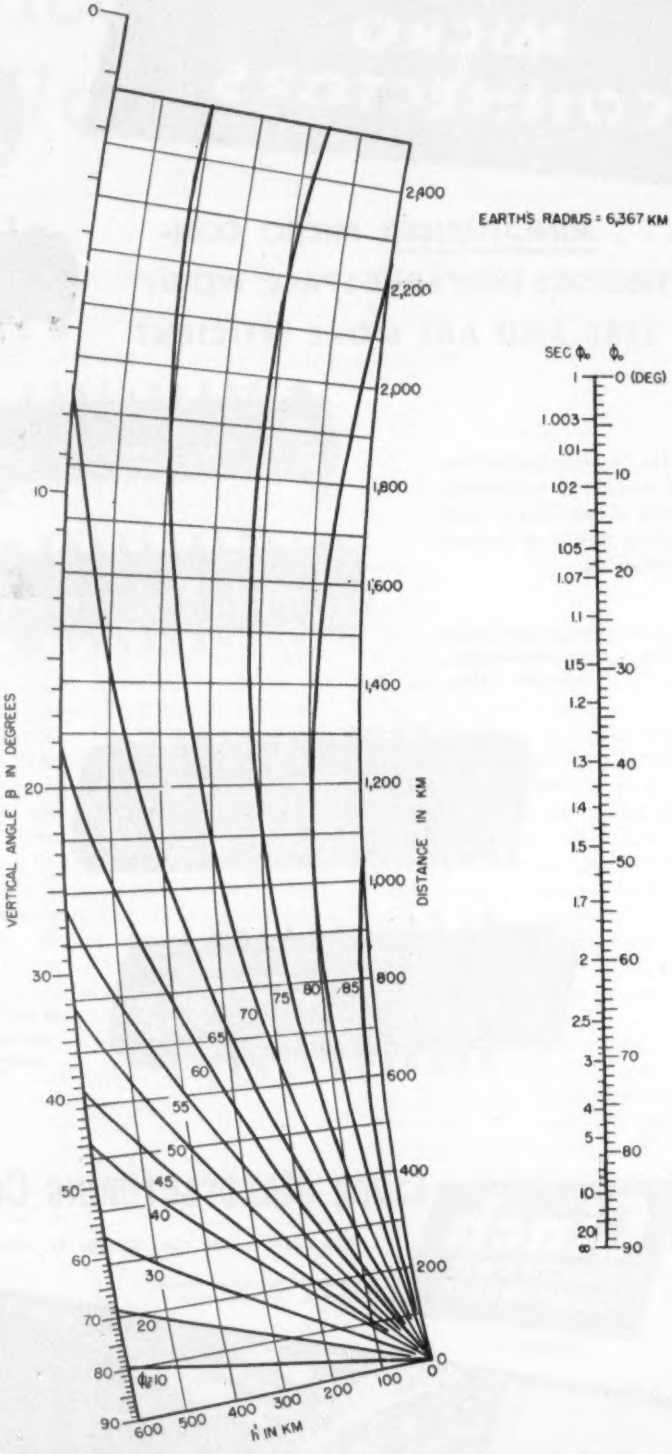

FIG. 2—Sky-wave transmission chart relates great-circle distance $D/2$ (see Fig. 1), virtual height, path distance, vertical angle and angle of incidence

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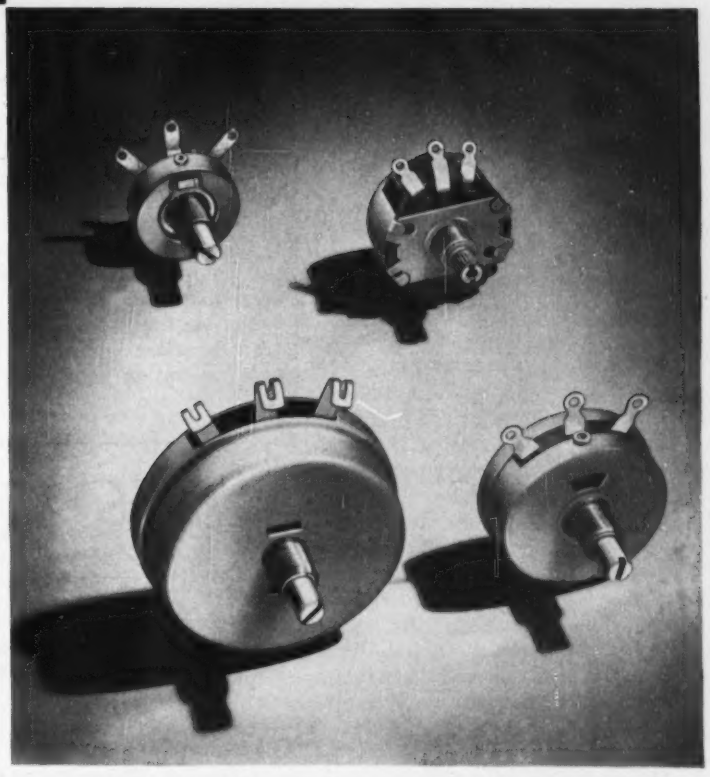

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Edited by ALEXANDER A. McKENZIE

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Type 6X4 Tube Applications

BY WALTER R. JONES
Panel on Electron Tubes
Research and Development Board
New York, N. Y.

Beginning with this issue, ELECTRONICS will publish a number of specialized tube application notes as they become available. This material results from activities of the Applications Subcommittee of the Panel on Electron Tubes, Committee on Electronics, Research and Development Board, with headquarters at 346 Broadway, 8th Floor, New York, N. Y. Working as teams, two or three tube applications engineers from the industry, together with a Service representative, have been investigating proposed uses of tubes in military equipment. Typical data obtained is presented below.

ONE OF THE MOST FREQUENT PROBLEMS encountered in military electronic equipment involves application of type 6X4 tubes in capacitor-input circuits at a power-supply frequency of 400 cycles. The problem arises because sufficient impedance is not included in each plate circuit to limit the steady-state peak plate current and the hot-switching current to their respective rated maximum values. When either of these currents exceeds the maximum safe rating, the tube may become permanently damaged and the power transformer and first filter capacitor may also be ruined.

To avoid many tedious calculations, three charts have been calculated that fulfill criteria for safe operation for type 6X4 operated with capacitor input. If the proposed operating point falls within

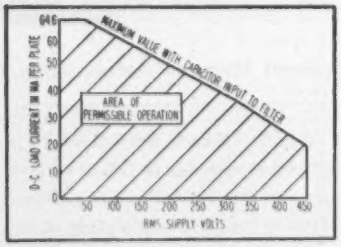
MAXIMUM VALUE WITH CAPACITOR INPUT TO FILTER
AREA OF PERMISSIBLE OPERATION
D-C LOAD CURRENT IN MA PER PLATE
RMS SUPPLY VOLTS

FIG. 1—Operation for 6X4 with 210 ma maximum safe peak steady-state current per plate

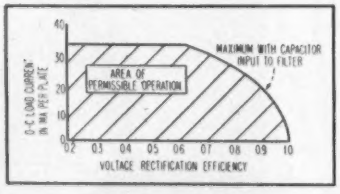
MAXIMUM WITH CAPACITOR INPUT TO FILTER
AREA OF PERMISSIBLE OPERATION
D-C LOAD CURRENT IN MA PER PLATE
VOLTAGE RECTIFICATION EFFICIENCY

FIG. 2—Load current vs efficiency for 6X4 for 210 ma peak steady-state current

the shaded area of all three charts, then the circuit should give reliable operation. Figures 1 and 2 are based on the assumption that the maximum safe peak steady-state current is 210 ma per plate, while Fig. 3 is based on the assumption that the maximum allowable hot-switching current is 1.8 amperes.

It is only necessary to make three measurements at maximum line voltage or primary supply voltage.

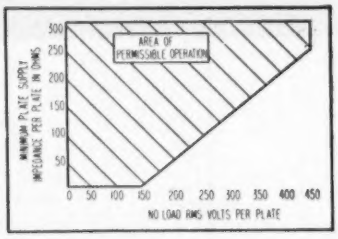

FIG. 3—Operation for hot-switching current of 1.8 amp

These measurements are:

(*A*) d-c load current (divide this value by 2 if full-wave circuit is employed).

(*B*) d-c voltage at input to filter

(*C*) a-c rms no-load voltage across transformer secondary (half of winding if full wave circuit is employed). A high resistance voltmeter must be employed in order that the true no-load voltage is obtained. Fig. 4 indicates where these measurements are made. A calculation of rectification efficiency is made by dividing

$$(B)/1.4\ (C)$$

The operating point can thus be located on Fig. 1. If this point falls within the area of permissible operation then the operating conditions can be checked on Fig. 2. In the event that the proposed conditions satisfy both charts then it can be certain that the maximum safe steady-state peak current will not be exceeded. If the point is outside the area of permissible operation, the operating conditions should be changed so that the new

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Specifications

FREQUENCY: 0.5 mc to 250 mc in eight ranges.
Rp RESISTANCE RANGE: 15 to 100,000 ohms.
Cp CAPACITANCE RANGE: +20 μμf to—100 μμf.*

*Capacitance range may be increased to ±120 μμf by use of external coils or condensers.

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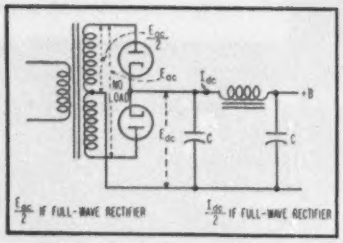


FIG. 4—Reference diagram for measurements described in text

point falls within the shaded area.

The simplest method of altering operating conditions is to add sufficient series resistance in the center lead or in each plate lead of the transformer to bring the rectification efficiency within the necessary limits. These charts are computed on the basis that 150 ohms per plate, the rated value, has been added to the circuit.

Assuming the proposed operating conditions indicate Fig. 1 and 2 are satisfied, there remains still one more condition—the safe value of hot-switching current that would flow in the circuit. Hot-switching current is that current that would flow if the filter becomes shorted or in the event that the circuit is turned off long enough to permit the input filter capacitor to discharge and is immediately turned on again while the cathode is still hot enough to conduct, such a current flows.

Figure 3 indicates the minimum plate supply impedance per plate required for safe operation for any given a-c plate supply voltage. A simple although not completely accurate method of determining the minimum plate supply impedance per plate is to measure the value of d-c resistance for half the transformer secondary winding (for full-wave operation) and add to that value the additional resistance supplied to the circuit to meet the conditions of Fig. 2. If this value of total resistance is not as high as indicated in Fig. 3 additional resistance should be added to satisfy this condition.

If the conditions indicated in all three charts are complied with, the power-supply problems, regardless of the power-supply frequency and the value of input capacitance to the filter, will be greatly reduced. It is true, of course, that the regulation will be worse with the additional resistance but for a given supply voltage and a given resistance a definite amount of current must flow. The analysis given above holds for sine-wave input. If the waveform differs from this, the peak currents may even be higher than indicated.

Transistor Organs

By James D. Fahnestock
Associate Editor, Electronics

Commonest among the point-contact transistors available today at reasonable cost is the Western Electric 1698, a point contact version intended primarily for use in switching circuits. One or more spares can be applied, in conjunction with a handful of inexpensive parts, to a number of applications —one of which is the electronic organ shown in the accompanying photograph. Several versions are described, including one circuit that permits the playing of any two notes on the keyboard simultaneously with only one set of frequency-determining capacitors and two transistors.

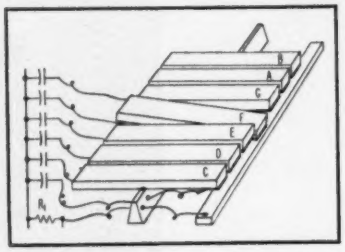


FIG. 2—Wooden keys of toy piano are modified as shown to serve as spst switches for playing notes of transistor organ

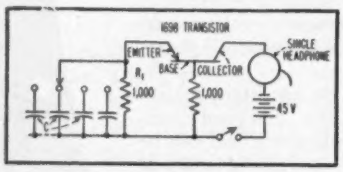
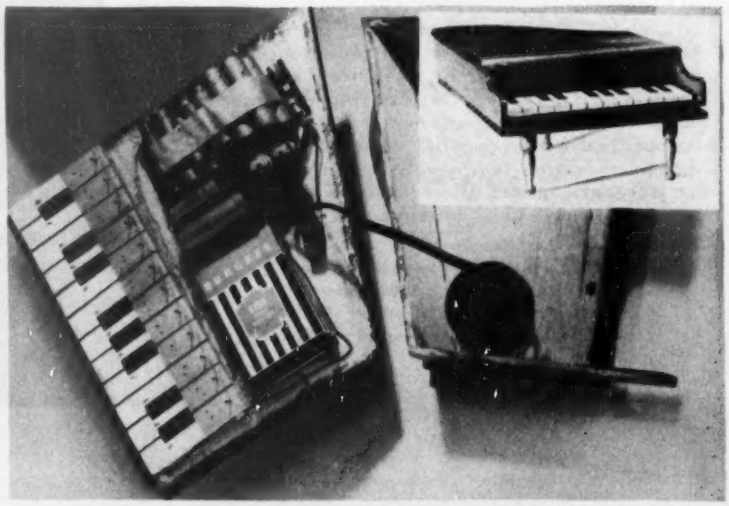


FIG. 1—Circuit of R-C oscillator for toy transistor organ

The basic circuit employed is shown in Fig. 1. This circuit is a simple relaxation oscillator that provides a pleasing tone in the headphone. Volume is sufficient to be heard all over a large-size room. The exact values of capacitors must, of course, be determined by trial and error. Any desired note may be obtained, by applying the proper value of capacitance across the emitter resistor R_1, from a few cycles per second up through the entire audio range. Output decreases slightly with frequency,



Transistor organ uses a toy piano case and keyboard (see inset upper right) for all components and battery shown in principal photograph. Single headphone is mounted against top (at right)

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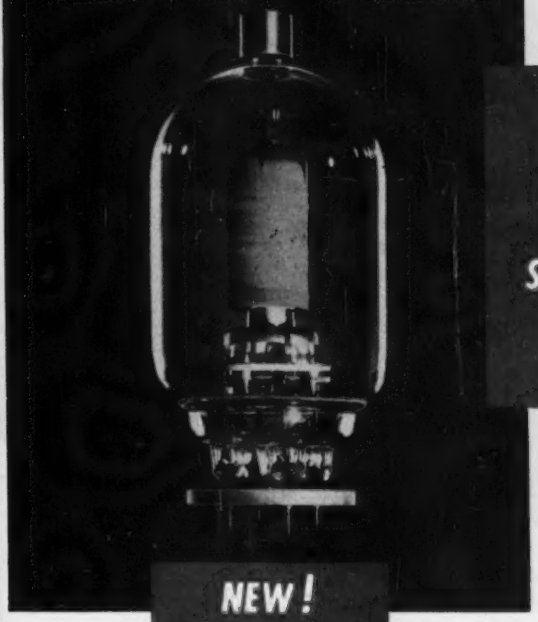

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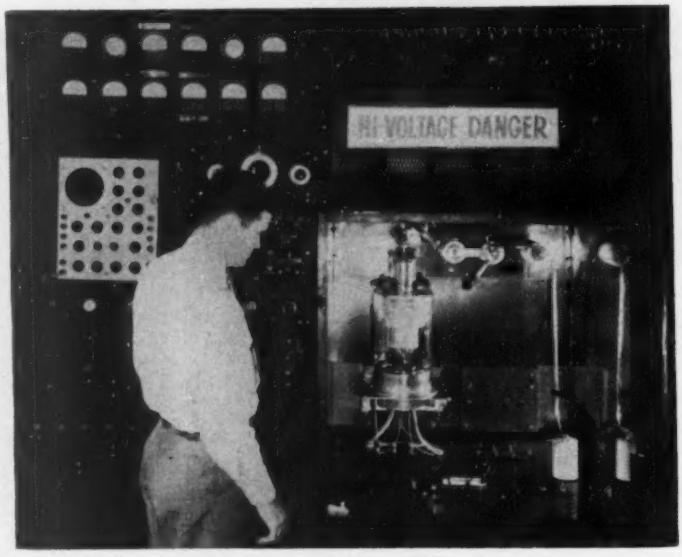

however, so for loud tones, the low notes are preferred.

Different ranges may be obtained by varying R_1, but different values of capacitance are needed to obtain frequencies in musical progression.

The experimental unit shown in the photograph was made from a child's toy piano by removing the resonant rods and hammers and modifying the keys as shown in Fig. 2. Thin strips of brass were tacked to the ends of each key and a strip of brass running below the metalized tips of the keys serves as a common bus.

With appropriate capacitance values connected by small flexible wires to each key notes of the scale can be played. Interesting combinations of low notes can be synthesized by depressing combinations of keys simultaneously, which parallels clusters of capacitors to produce low frequencies.

Two-Note Organ

Considerably more flexibility can be obtained at the cost of some added complexity as illustrated in Fig. 3. With the arrangement shown, combinations of two notes may be played with a single keyboard and a single set of frequency-determining capacitors, and two transistors.

Collector current averages 3 to 5 ma, which is well within the limits of the 1698 transistor, and allows for long life of the 45-volt battery.

In experimenting with values for C and R_1, it is advisable to place a 0 to 5 ma meter in series with the collector to protect the transistor against accidental overloads. The value of 1,000 ohms for R_1 will work for most 1698's, but variations may be desired for changing range, or for tuning up with instruments. A 5,000-ohm potentiometer was used in the experimental organ shown, but it is usually set at the 1,000-ohm value. An octave is covered by eight sets of capacitors ranging from about 0.75 to 0.25 μf. The switch is provided in the collector lead to disconnect battery when organ is not in use, since some battery current flows when no keys are depressed.

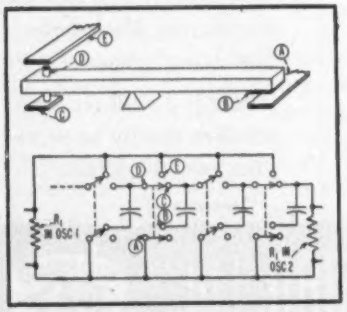

FIG. 3—More elaborate keyboard permits playing of two notes simultaneously with a single set of frequency-determining capacitors. Circled letters on key refer to points on circuit below

PERTINENT PATENTS

EACH WEEK many hundreds of patents are granted to inventors in all of the arts to which patents apply. A survey of recently issued patents made over an arbitrarily selected period of four months during 1952 reveals that of all the patents issued in any week the average number of those applicable to the electrical and electronic arts represents 12 percent of the total. A maximum of 14 percent of all patents was electrical or electronic in the week containing the largest relative number of these patents. The minimum number represented 8 percent of the total.

Patent Groupings

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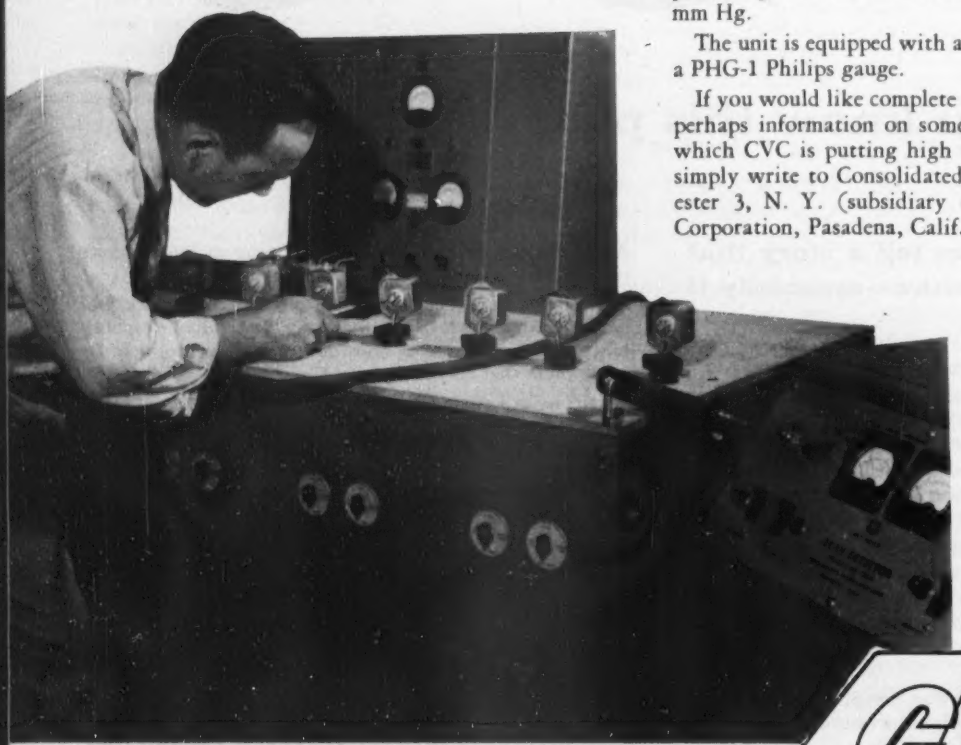

CVC's 10-Port Vacuum Manifold System in use at Barber-Colman Company, Rockford, Illinois.

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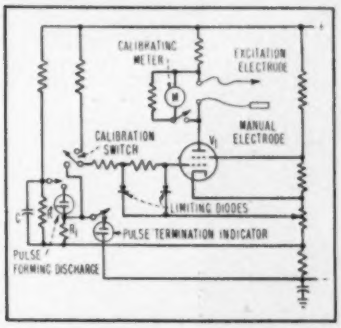

FIG. 1—Pulser used to determine health of tooth pulp

now included in its *Official Gazette*. The publication groups all mechanical and general patents in one section and all chemical patents in a second. Electrical patents (including electronic devices and circuits) are in a third grouping. In each of the sections other than electrical there may be included occasionally devices that are electrical or electronic in nature. As an example, phonograph pickups, motors and record changers have been found in the mechanical and general section. Semiconductor devices, particularly those features dealing with the structure of the materials employed, crop up in the chemical section.

New Patent Law

A new Patent Law of 1952 went into effect January 1953. This law modifies previous law and codifies the several laws pertaining to patents into U. S. Code section 35. There will be, accordingly, changes in the rules of practice in the prosecution of patents before the Patent Office and in the operation of the

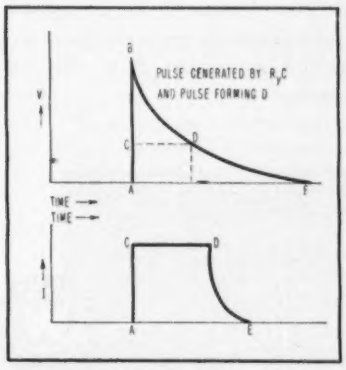

FIG. 2—Pulse forms required for dental testing

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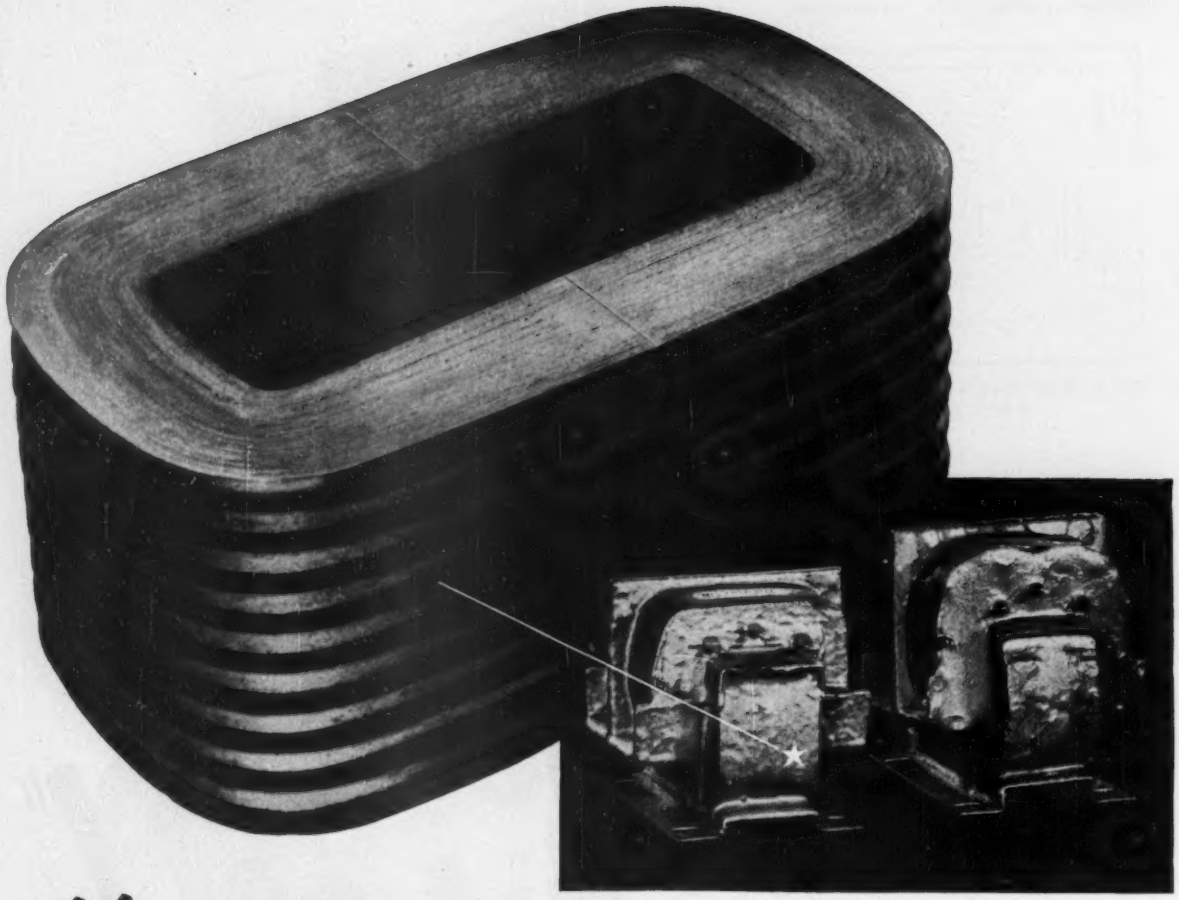

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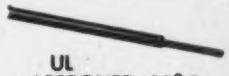
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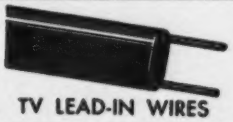
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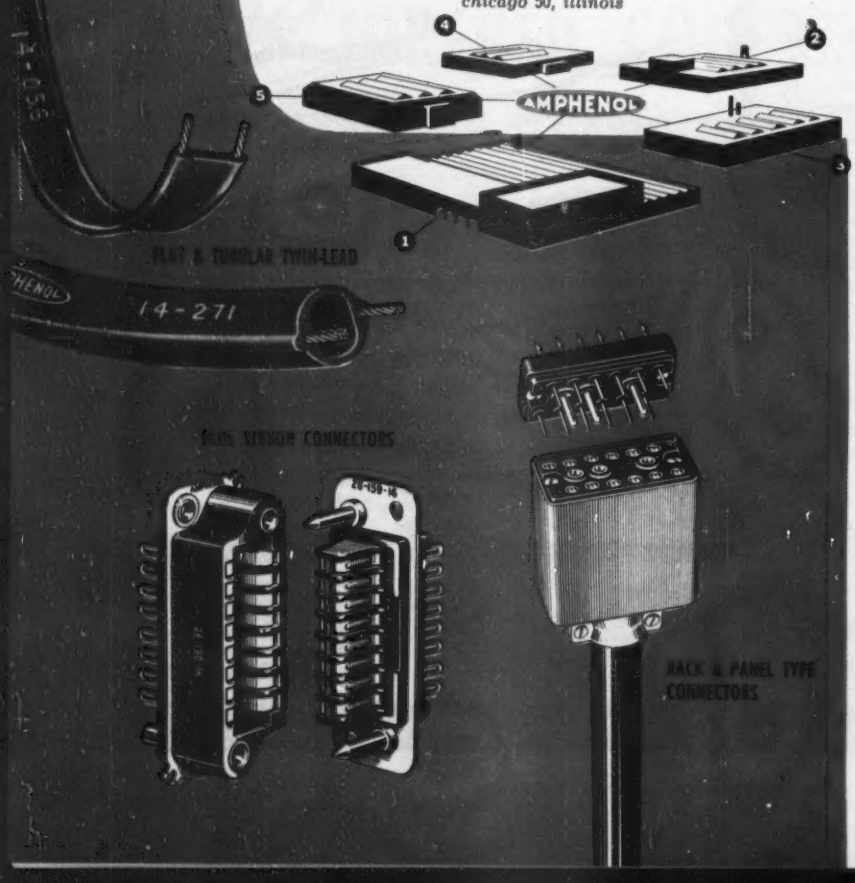

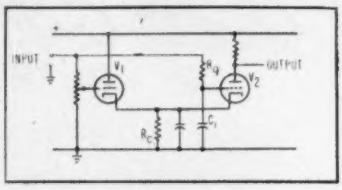

FIG. 3—Pulse-width discriminator circuit

rules regarding infringement and contributory infringement. Manufacturers of electronic equipment and component parts, would do well to have their patent departments inform them about details of the new laws.

Dental Pulser

Active interest has been shown by ELECTRONICS readers in the diagnostic applications of electronic devices in medicine. The grant of U. S. Patent 2,603,753 to Karl N. Axelssohn, and Carl H. Bjorn, of Djursholm, Sweden for an "Apparatus for Examining Teeth" is in line with this interest. In Fig. 1 the circuit diagram of the apparatus is shown. In Fig. 2, there are shown waveforms of the output of the device as applied in dental pulp testing.

A pulse of current generated by the device is used to excite the patient's tooth to determine whether the pulp is dead or anaesthetized. The strength of the current *AC* of Fig. 2. at which the threshold of feeling is observed is the measure of the state of health of the pulp. If no reaction is observed at a level of 40 to 60 μamp this is evidence of anesthetization or necrosis of the pulp.

There is a definite requirement of a steep rise in the initial pulse period, but the decay period does not necessarily have a similarly steep fall. The pulses, however,

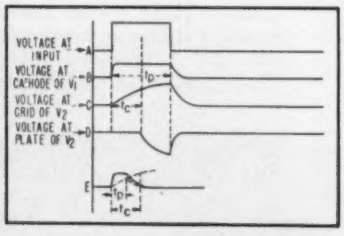

FIG. 4—Waveforms show operation of discriminator

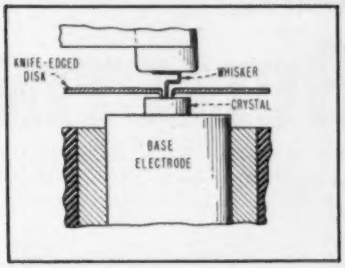

FIG. 5—Mounting and contacts for crystal triode

must be unidirectional and have a substantially rectangular shape, rising to the intended value steeply and remaining at this level for a predetermined period, which in practice is 5 to 40 milliseconds.

The circuit for generating the pulse may be any well-known pulse generator device. The inventors' preferred embodiment is shown in Fig. 1. A pulse having the shape ABE is generated across resistor R_1 by RC network and the gas-discharge tube acting as a relaxation oscillator. The pulse applied to the amplifier grid is limited by the diodes shown to a shape $ACDE$. The output of the amplifier is applied through electrodes one of which contacts the tooth and the return circuit electrode is held in the patient's hand.

Pulse Width Discriminator

Patent 2,609,501 has been granted to G. B. Guthrie Jr., assigned to the United States of America as represented by the Secretary of War, for a "Pulse Width Discriminator Circuit." The circuit of this invention is shown in Fig 3. A group of representative waveforms is shown in Fig. 4. The circuit will accept only pulses of a critical duration t_c or greater and is independent of the amplitude of the pulse. Tube V_1 is normally conducting; V_2 is nonconducting by virtue of the drop across the common

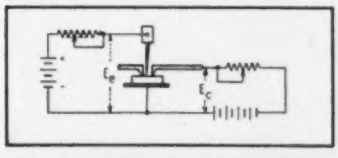

FIG. 6—Circuit of the disk-contact crystal triode

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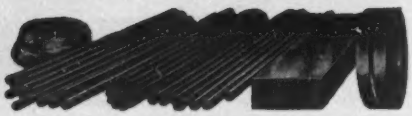

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Communications Receiver Uses Copper-base Alloys for Rugged, Trouble-free Service

Hard practical experience gained during extreme service conditions in World War II and the present Korean War dictated the necessity of using strong, dependable, corrosion resisting materials in the construction of the R-366/TRR5 radio receiving set designed for use by the United States Marine Corps. Ocean spray, wide temperature and humidity ranges, rough handling, and a minimum of maintenance care are a few of the many points which required consideration.

It is only natural that copper-base alloys due to their resistance to corrosion, ease of machining, ability to take plating, and lack of magnetic properties should play an important part in the construction of this receiver. For example, brass is used for brackets, mounting hardware, gears, bushings, solder lugs, control shafts, tube socket bases, shields, etc.

For dependable electrical and mechanical contacts, hot tinned brass (70% copper, 30% zinc) solder lugs are used exclusively on all terminal boards. They are easy to manufacture, take solder well and offer high resistance to corrosion.

Band Switching Assembly

A highly efficient positive acting band switching arrangement for trouble-free service is one of the main features of this receiver. The coils are completely enclosed fully protecting them from dirt and damage from handling. Screw studs made from free machining brass rod (approximately 61% copper, 3.4% lead, remainder zinc) support the tuning slugs used for adjusting the various circuits and are located on the ends of the two large housings for making adjustments without opening the sealed units and exposing the coils. The complete assembly is suspended between two cast bronze brackets for rigidity.

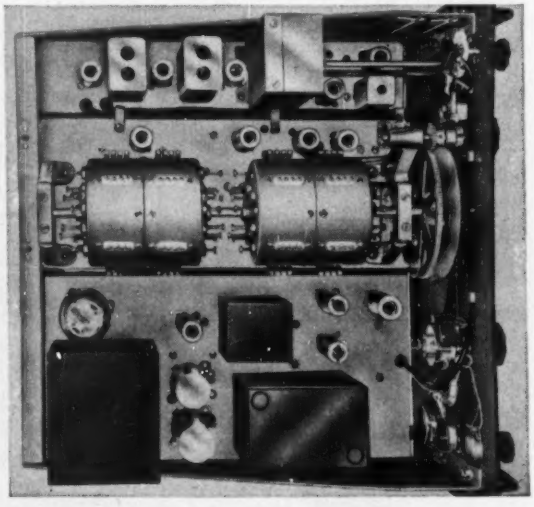
The band selector switch operates through a geared mechanism consisting of a brass gear (approximately 62.25% copper, 2% lead, balance zinc) and an indexing device which rotates the two coil housings, changing their beryllium copper supported coin silver contact points and connecting the 32 phosphor bronze (approximately 95% copper, 5% tin) shorting fingers. In this manner, the desired coils are connected into the circuit and the unused ones completely disabled.

Brass Tube Shields

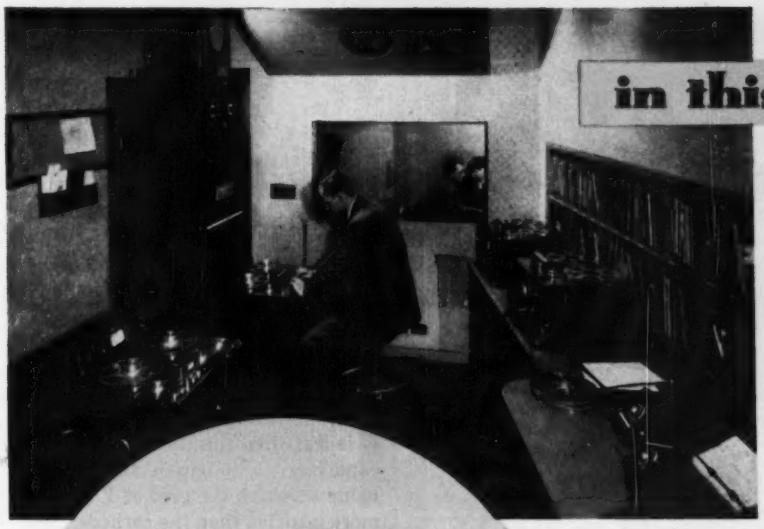
Fifteen nickel-plated cartridge brass (70% copper, 30% zinc) tube shields are used to prevent unwanted voltages from being picked up or radiated by the various tubes. The shields are fastened to nickel-plated brass shield bases which are formed to the tube sockets. The shields themselves are removable to allow tube changing.

Bridgeport Brass Service

Bridgeport Brass supplies a wide range of copper-base alloys used in the electronic field. As a special service to electronic manufacturers, our Laboratory will be glad to assist in choosing the proper alloys for the many different applications found in their field. Call or write to your nearest Bridgeport representative. (9417)



Top view of receiver R-366/TRR5 showing Band Switching Assembly, which has brass gears, cast bronze mounting brackets, and phosphor bronze shorting fingers. Other brass parts illustrated are tube shields, control shafts, tuning slugs, and mounting brackets. Courtesy Espey Mfg. Co., New York



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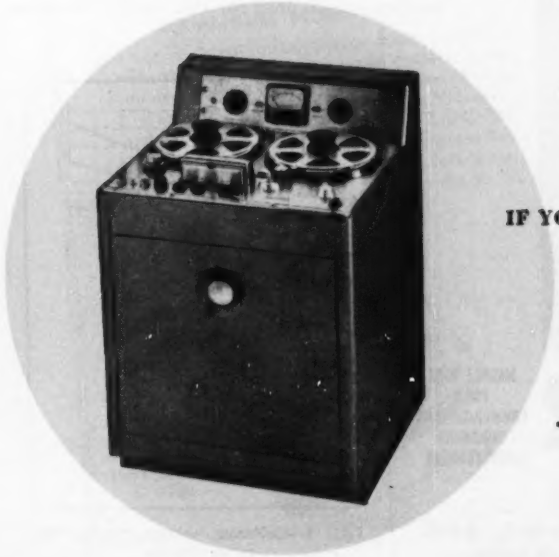
There can be no room for doubt in the continuity and fidelity of your broadcast. Precisely the reason you demand — and get — the best in transmitting and studio equipment.

Nor should you compromise with quality in the tape recorder you select.

In AMPEX Recorders you will find the same matchless reliability and performance you expect of your transmission equipment . . . and for the same reason — they are engineered to the highest *professional* standards.



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brings you these cost-saving operating advantages:

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  Under the demand of heavy-duty programming, AMPEX Recorders deliver thousands of hours of unbroken service. Recently a set of AMPEX heads was returned from Honolulu for routine replacement after 11,000 hours continuous use, 17 hours a day. The heads were still within AMPEX specifications for new heads and had several thousand more hours of use remaining.
- **MINIMUM "DOWN TIME"**
  AMPEX Recorders are designed for thousands of hours of continuous operation with minimum "down time," resulting in low maintenance costs and protection from sudden broadcast failures.
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- **LONG LIFE**
  AMPEX Recorders are designed and built for years of service dependability. Its recordings match established NARTB standards. When you have an AMPEX, you have a machine built for years-ahead performance.

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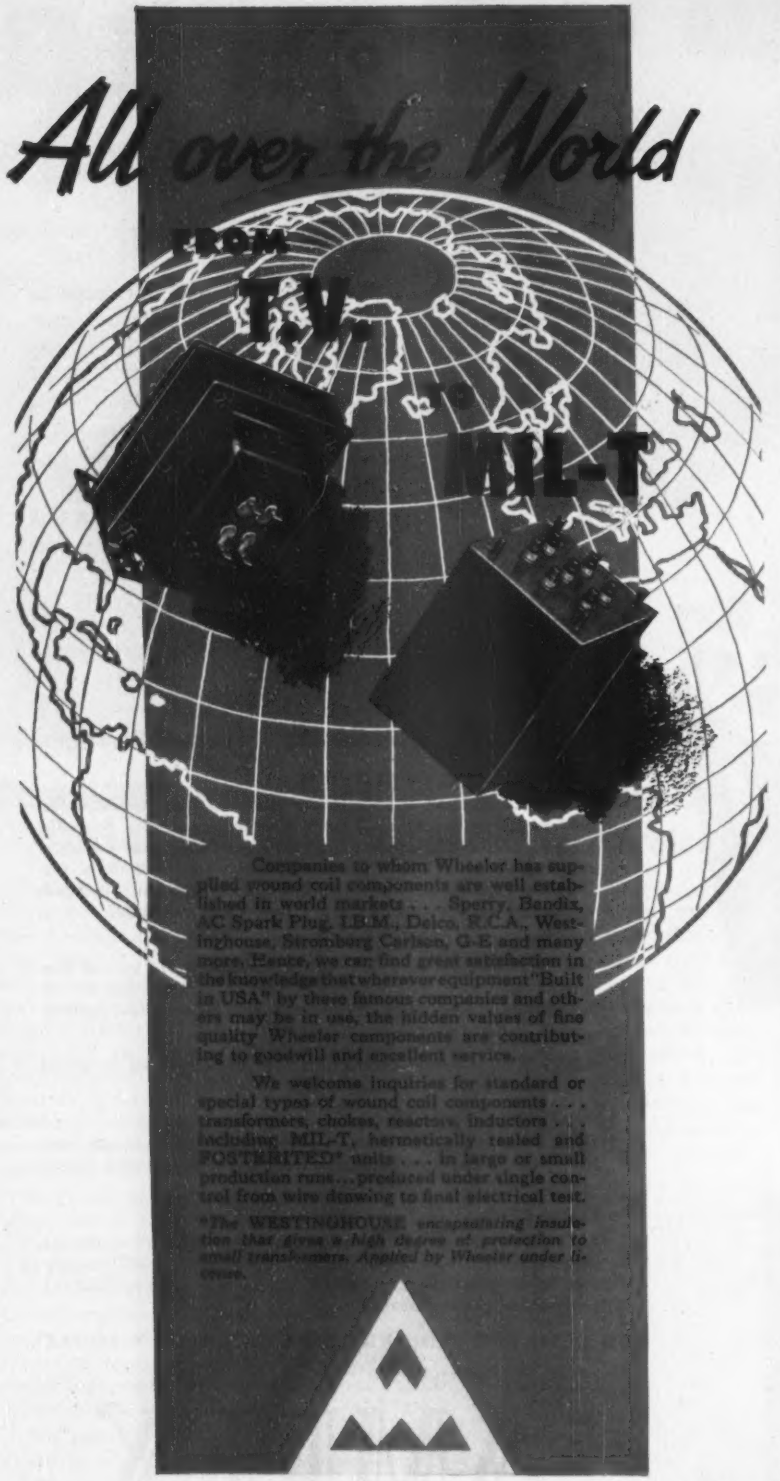

Companies to whom Wheeler has supplied wound coil components are well established in world markets . . . Sperry, Bendix, AC Spark Plug, I.B.M., Delco, R.C.A., Westinghouse, Stromberg Carlson, G-E and many more. Hence, we can find great satisfaction in the knowledge that wherever equipment "Built in USA" by these famous companies and others may be in use, the hidden values of fine quality Wheeler components are contributing to goodwill and excellent service.

We welcome inquiries for standard or special types of wound coil components . . . transformers, chokes, reactors, inductors . . . including MIL-T, hermetically sealed and POSTERITED* units . . . in large or small production runs . . . produced under single control from wire drawing to final electrical test.

*The WESTINGHOUSE encapsulating insulation that gives a high degree of protection to small transformers. Applied by Wheeler under license.

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cathode resistance R_c.

A signal as shown in waveform *A* applied to the input of V_1 appears at the cathode as shown in waveform *B*. At the grid of V_2 the waveform of *C* appears because of the integrating action of R_g and C_1. When at time t_c the voltage across C_1 equals the amplitude of the pulse appearing on the cathode of V_2 (same as cathode of V_1), V_2 becomes conducting to produce a negative output pulse as at *D*.

If, however, the pulse duration t_p is less than the time required for capacitor C_1 to reach the critical value at which the grid of V_2 will be more positive than the cathode, then V_2 will not conduct and not pass the pulse. This condition of operation is shown in waveform *E*.

Knife-Edge Transistor

In the transistor fields patents are currently appearing in rapid succession. Recent patent 2,610,234 granted to A. H. Dickinson, assignor to the International Business Machines Corp., for a novel "Crystal Triode" is of some interest as an indicator of development trends in this art.

To overcome disadvantages of two point contacts in the conventional transistor, Dickinson's transistor employs a whisker as the emitter element and a knife-edged cylinder attached to a disk. The disk surrounds the whisker tip in a construction that can be seen in Fig. 5. A circuit connection that can be used for this crystal is shown

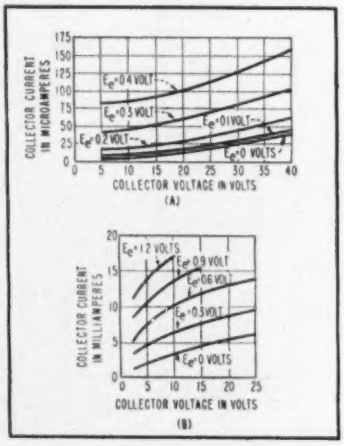

FIG. 7—Collector voltage versus collector current

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Identical, Highly Stable D-C Amplifiers! Better High Frequency Response than any other scope in its field!

FROM low level DC measurements requiring good stability to observing wave forms with significant components as high as 1 mc, the ST-2B gives outstanding service. Designed to permit a choice of short, medium or long persistence CR tubes, the unit incorporates identical direct coupled vertical and horizontal amplifiers. Filaments and screens on the first amplifier stages are regulated. Vertical selector switch allows choice of probe, calibration, AC or DC inputs.

SPECIFICATIONS—MODEL ST-2B

FREQUENCY RESPONSE

Vertical Amplifier
DC — 0 to 400 kc, +0, −20%, not more than 50% down at 700 kc.
AC — 10 cycles to 400 kc, +0, −20%, not more than 50% down at 700 kc.
Probe — 2 cycles to 400 kc, +0, −20%, not more than 50% down at 700 kc.
Response independent of gain or attenuator setting.

Horizontal Amplifier
DC — 0 to 400 kc, +0, −20%, not more than 50% at 700 kc.
AC — 10 cycles to 400 kc, +0, −20%, not more than 50% down at 700 kc.
Response independent of gain or attenuator setting.

SENSITIVITY

Vertical	AC—10 mv. rms/inch DC—28 mv. dc/inch
Horizontal	AC—15 mv. rms/inch DC—42 mv. dc/inch
Probe	130 mv. rms/inch
Deflection Plates Direct	
Vertical	22 volts rms/inch
Horizontal	25 volts rms/inch

SWEEP

Range—Triggered or recurrent—2 cycles to 30 kc (may be extended downwards by adding external capacity across panel jacks).
Sync— ±Internal, ±line and —Ext. (requires —.3 volts peak to peak for external sync). Sync limiter on recurrent position.
Sweep Expansion—At least 4 times tube diameter.

PHASE SHIFT—Negligible phase shift between amplifiers from 0 to 300 kc.

BLANKING—Z-axis blanking requires 20 volts peak to blank.

CALIBRATION—Eight voltages available by selector switch: .1, .3, 1, 3, 10, 30, 100 and 300 volts peak to peak ±15%.

DIRECT CONNECTIONS TO DEFLECTION PLATES—Available through capacitors—internal positioning circuits still function.

GERMANIUM DIODE CHECKER

For use in laboratories, quality control groups, service shops. Measures the static characteristics of diodes. FORWARD RANGES: Current—0.3, 1.2, 6 and 12 milliamperes full scale. Voltage—.3 and 1.2 volts full scale. INVERSE RANGES: Current—60, 120, 300 and 1200 microamperes full scale. Voltage—3, 12 and 120 volts full scale. POWER REQUIREMENTS: 105-125 volts, 50/60 cycle, approximately 10 watts.

Type ST-12A

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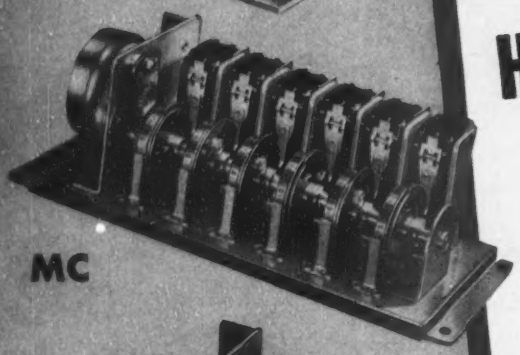

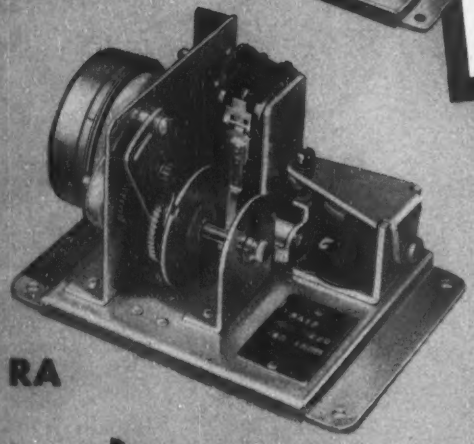

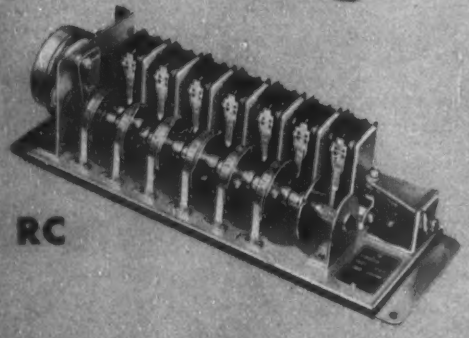

These Industrial Timer Corporation timers provide accurate and highly dependable instruments for control of a single operation or multiple operations (simultaneously or in sequence).

OUTSTANDING FEATURES ARE:

(1) the wide range of over-all time cycles obtainable from any one model;

(2) the ease with which over-all time cycles can be changed;

(3) the simplicity with which individual cams can be adjusted for ON and OFF periods, and positioned in specific timing sequence.

Highly Dependable

Synchronous Motor Driven

Cam Timers

Series CM CAM RECYCLING TIMERS

The Series CM Cam Recycling Timer repeats a definite electrical ON and OFF time cycle continuously. The cam is coupled to the motor by means of a simple gear and rack assembly—and the over-all time cycle can be easily changed by substituting gear racks. (Bulletin 33)

Series MC MULTI-CAM TIMERS

The Series MC Timer is identical to the CM Timer, but operates 2 to 6 circuits. All cams are mounted on a single shaft, which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. (Bulletin 34)

Series RA SINGLE CYCLE CAM TIMERS

The Series RA Timer provides a single time cycle upon being actuated electrically from remote control. A pawl on the cam eliminates necessity for prolonged closing of relay switch when starting. (Bulletin 35)

Series RC SINGLE CYCLE MULTI-CAM TIMERS

The RC is identical to the RA, but operates from 1 to 6 additional circuits. Thus it provides all the features of the Series MC Timer, plus the single cycle control afforded by the RA. (Bulletin 35)

Send us specifications, and we shall make recommendations based on your particular needs. Bulletins sent free on request.

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High stability (.003%) under normal operating conditions.

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Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3 AM. Stability .003% using CR-7 (or HC-6U) crystals. Operates in ambient 0° to + 45° C using mercury rectifiers;-35° to + 45° C using gas-filled rectifiers. Power supply, 200-250 volts, 50/60 cycles, single phase. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

AER-O-COM

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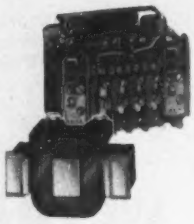

Full accessibility in a small package.

Contacts, coil and thermal element replacement with use of screwdriver only. Magnet coil—in molded phenolic case with riveted terminals—is completely embedded in a rock-hard resinous material, thus protecting against oil, dirt, moisture and normal mechanical damage.

HERMETICALLY SEALED RELAYS
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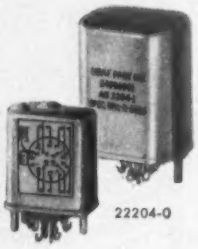

50% smaller — lighter.

R-B-M 22204-0 meets AN 3304-1 specifications. R-B-M engineers have developed the 22300-0 currently used in government electronic, airborne and ground equipment—as the electrical and mechanical equivalent of the AN 3304-1, yet 50% smaller in size with ½ the weight.

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with Plasti-Clad Magnet Coil
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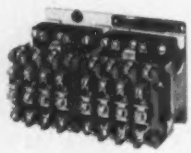
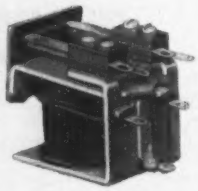


2-8 poles Non-Reversing.
2-5 poles Reversing.
25 Amp — 600 AC Max.

Contacts can be replaced without removing wiring. To change coil, remove magnet frame and coil assembly only. 10 and 15 amp. poles can be changed from normally open to normally closed by using screwdriver only.

GENERAL PURPOSE RELAYS
•
Write for Bulletin 570
•



Low cost. Small size. Dependable performance. Available in many contact arrangements.

Whatever your needs for inexpensive, dependable relays for commercial applications—investigate R-B-M General Purpose Relays.

Other R-B-M products include: motor overload protectors, motor starting relays and low voltage DC electrical devices.

Consult R-B-M On Your Control Problems — Write Department B-2

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Logansport, Indiana

MANUAL AND MAGNETIC ELECTRIC CONTROLS FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE

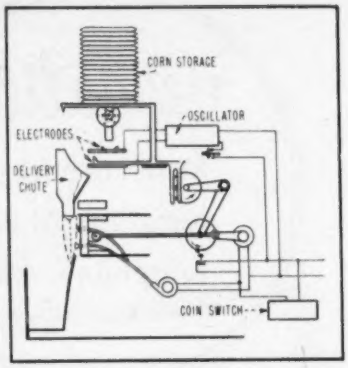

FIG. 8—Corn popper uses r-f to explode kernels in plastic bag. Alternative system pops corn, bags it later

in Fig. 6 on p 165.

Performance of the Dickinson crystal triode is indicated in the curves of Fig. 7, which compare the output vs input characteristics of the Dickinson crystal with typical crystal triodes previously reported.

More output voltage for a given input signal and a lower output impedance are claimed by Dickinson, and in view of the latter characteristic a greater response at higher frequencies of operation.

Corn Popper

Use of electronics for automatically popping corn in a coin-operated vending machine is the subject of patent 2,603,142 granted to C. C. Miller of Altadena, Calif. for "An Apparatus for Popping Corn by High Frequency Radiation."

A measured quantity of corn kernels already sealed in their plastic container are passed through the dielectric field of an r-f oscillator and the kernels are popped instantaneously. A diagram of this mechanism is shown in Fig. 8.

Transistor Amplifier

Patent 2,609,459 granted to G. Bergson, assignor to the Radio Corp. of America, for a high-input

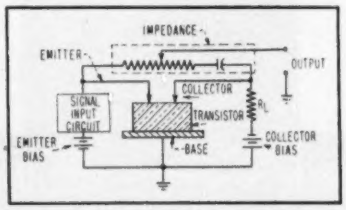

FIG. 9—Transistor amplifier uses impedance between emitter and collector

Series AJ Helipot models are only ¾" in diameter and 1⅛" long; weight 1.0 oz. Ten-turn 18" slide wire gives adjustment accuracy of 1/3000 in a 100-ohm unit—1/6500 in a 50,000-ohm unit.

Helipot achieves "HIGHEST PRECISION" with DRIVER-HARRIS RESISTANCE WIRE

Cutaway view of Model A 10-turn Helipot precision helical potentiometer. Resistance element 4½" long is contained in case 2" x 1-13/16" diameter. On element are wound 1003 to 9800 turns of resistance wire, depending on total resistance value required. Adjustment accuracy is 12 to 14 times that of conventional single-turn potentiometer of equal diameter.

To win consumer preference and assure customer satisfaction, Helipot Corporation is guided by a basic policy that has proved as effective as it is simple. It is: (1) to produce components of the highest precision, and (2) to realize the economies inherent in mass production.

By following these objectives, Helipot has become the world's largest maker of precision potentiometers, producing the widest selection of single-turn and multi-turn units available anywhere.

States Helipot: "Our policy of mass producing the highest precision potentiometers practicable, in order to deliver top quality at moderate cost, is reflected in the fact that standard linearity accuracy of all our stock models, selling competitively, is held to ±0.5%. Our reliance on Driver-Harris alloys such as Nichrome V, Advance, and Karma to provide resistance windings for many of our products constitutes a strong endorsement of Driver-Harris skills and reliability."

Driver-Harris takes particular pride in having played so important a role in the Helipot story, and is fully conscious of the responsibility the confidence of this famous manufacturer imposes.

Nichrome*, Advance*, and Karma* are at your service, too; as are more than 80 other alloys developed exclusively by Driver-Harris for application in the electrical and electronic fields. We feel confident that, like Helipot, you will realize outstanding advantages by putting one or more of them to work for you. Let us have your specifications. We'll be glad to make recommendations based on your specific requirements.

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Sole producers of Nichrome, Advance, and Karma

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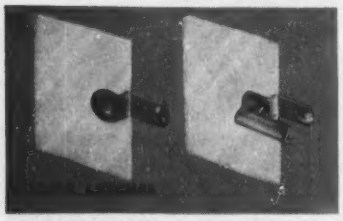

Holding power, speed and ease of installation, elimination of special tooling, convenience of use in opening and closing applications . . . each factor involved is analyzed to assure the best fastener at lowest possible cost. When special designs are indicated, the experience and background of SOUTHCO engineers in solving thousands of fastener problems can be of special value to you.

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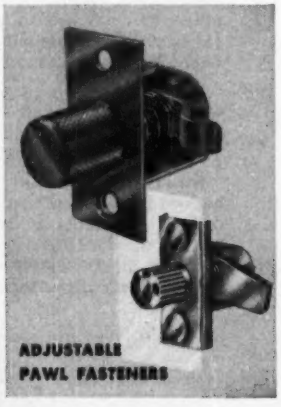

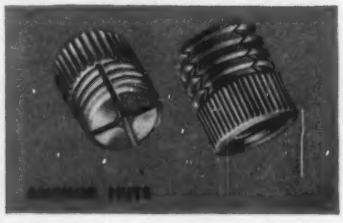

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WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

MICROWAVES EQUIPMENT...

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V.H.F. TO S.H.F.
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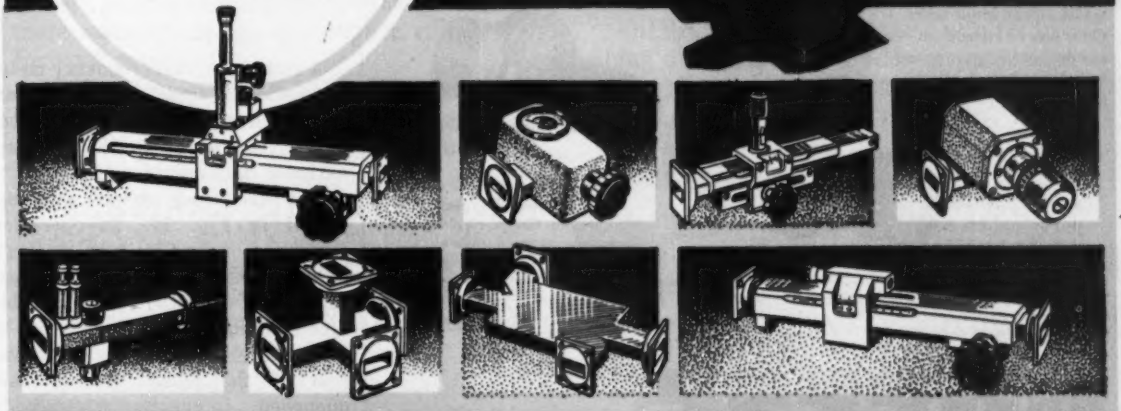
RADAR TEST SET
S AND X BAND



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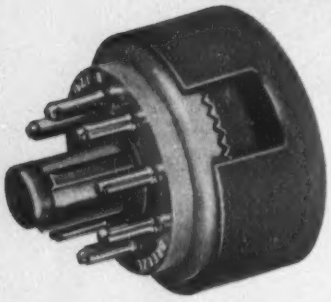
Two Special Purpose Connectors by

BREEZE MARK



Quick Disconnect

Simply push male and female members together and lock. To disconnect with minimum resistance, pull back sleeve on plug shell and disconnect. Exceptionally low disengaging force required (less than 6 lbs., excepting pin friction). Vibration proof, moisture-proofed with synthetic rubber insert. Meets AN pin pattern and voltage requirements, in accordance with MIL C-5015. Plug shell and coupling sleeve are aluminum alloy, cadmium plated and iridite-sealed. (Federal Spec. QQP—416, Type 2.)

Battery Connectors

8-pin type for both A and B batteries used in all types of field communication equipment. "RUGGEDIZED" for extra security and long service life: polarizing stud is ALL METAL and all metal parts are cadmium plated and sealed with an iridite sealer. Cable may be brought out at any desired side position and locked. Handy bail makes removal from inaccessible places easy.

Receptacle Types: Round flange single hole panel-mounted, square flange for 4 bolts, or specially flanged to specification. All contacts silver plated.

We invite your inquiries on any problems concerning connectors. Our wealth of engineering experience in this specialty is at your service.

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41 South Sixth Street, Newark, N. J.

impedance transistor amplifier describes circuit means for accomplishing the claimed results.

By the insertion of an impedance between the emitter and collector electrodes, as shown in Fig. 9, Bergson shows that when the output is taken from a point on this impedance the input impedance of the transistor amplifier is raised to a much higher level. Improvement results in the operation of transistor amplifiers by reduction of the load-

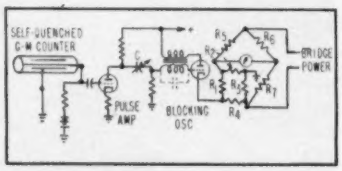

FIG. 10—Frequency meter measures discharge of Geiger tube

ing effect of the normally low input impedance shown by previously disclosed transistor amplifiers.

Briefly the operation of the high-impedance transistor amplifier may be described as follows. The output is derived from load resistor R_1 in the collector circuit of Fig. 9. A part of the output current flows to the emitter circuit and opposes the emitter current to raise the input impedance and increase the gain of the amplifier.

Frequency Meter

A rather unusual frequency meter of particular application to Geiger-Muller tubes is the subject of patent 2,609,512 granted to H. Conviser, assignor to Bendix Aviation Corp.

The frequency meter is illustrated in Fig. 10. In operation ionization of the G-M tube applies a pulse of negative polarity across capacitor C on to the grid of a stable free-running blocking oscillator to quench the oscillator for the duration of the pulse. During this quenched interval the cathode bridge R_1, R_2, R_3 and R_4 made up of temperature-sensitive resistors and forming an arm of the Wheatstone bridge averaging circuit, will no longer have a potential across it to unbalance the bridge and provide

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Shown on these pages are various types and ranges of Helipots—both single and multi-turn—that Helipot now stocks for immediate delivery. You can have stock prototypes immediately. On large orders for stock items, initial deliveries in substantial quantities will be made promptly, with balance on close schedule.

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For fast service, call the nearest representative listed below.

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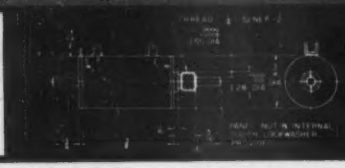
MODEL A HELIPOTS

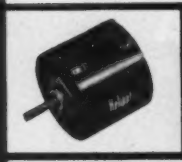
The most widely adaptable of all multiturn Helipots. A 10-turn unit of convenient, compact size offering resolution accuracies 12 to 14 times that of conventional single-turn units of same diameter. 10-turn range permits direct decimal readings.

10-turns . . . Power rating 5 watts . . . Coil length 46.5" . . . Linearity tolerances: ±0.5% (Std. all values), (±0.1% 5K and up, ±0.25% below 5K).*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
25-AZ	25	3,000	.00071
50-AZ	50	3,200	.00071
100-AZ	100	3,800	.00071
200-AZ	200	4,750	.00071
500-AZ	500	4,000	.00002
1,000-AZ	1,000	5,000	.00002
2,000-AZ	2,000	6,500	.00002
5,000-AZ	5,000	7,200	.00013
10,000-AZ	10,000	9,000	.00013
20,000-AZ	20,000	10,000	.00013
30,000-AZ	30,000	11,500	.00013
50,000-AZ	50,000	12,500	.00013
100,000-AZ	100,000	15,000	.00013
200,000-AZ	200,000	15,500	.00013
300,000-AZ	300,000	16,000	.00013





MODEL AJ HELIPOTS

The AJ is a high performance 10-turn helical potentiometer of miniature size (⅜" dia.) and light weight (1 oz.). Available with bushing mount (AJ) or servo mount (AJS), both with sleeve bearings. Servo mount also available with precision ball bearings (AJSP).

10-turns . . . Power rating 2 watts . . . Coil length 18" . . . Linearity tolerance ±0.5% (Std.) . . . Starting torque 0.75 oz. in. . . . Wgt. 1 oz. . . . Dia. ⅜".*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-AJZ	100	3,000	.00071
500-AJZ	500	2,500	.00002
1,000-AJZ	1,000	3,400	.00002
5,000-AJZ	5,000	4,250	.00013
10,000-AJZ	10,000	4,000	.00013
20,000-AJZ	20,000	5,350	.00013
30,000-AJZ	30,000	5,450	.00002
50,000-AJZ	50,000	6,550	.00002

MODEL B HELIPOTS

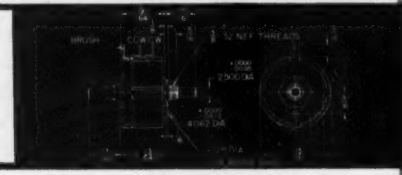
A large diameter (3-5/16") 15-turn Helipot with 139" slide wire length providing the highest resolution (.01% to .003%) and adjustment accuracy available today in a standard mass-production unit. Rugged, dependable, low in cost.

15-turns . . . Power rating 10 watts . . . Coil length 139" . . . Linearity tolerance ±0.5% (Std.).*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
1,000-BZ	1,000	10,900	.00002
5,000-BZ	5,000	19,600	.00002
10,000-BZ	10,000	17,700	.00013
25,000-BZ	25,000	21,800	.00013
50,000-BZ	50,000	25,400	.00013
100,000-BZ	100,000	34,100	.00013

Please note that 1000 volts is highest that may be applied across coil regardless of resistance value.



MODEL T HELIPOTS

A single-turn, continuous-rotation servo-mounting unit of minimum weight (0.56 oz.) requiring very small cubic space and operating with negligible torque. Shaft rotates on precision ball bearings—unit built throughout to highest possible precision.

1-turn . . . Power rating ½ watt . . . Coil length 2" . . . Linearity tolerance ±0.5% (Std.) . . . Starting torque .015 in. oz. (Running torque is negligible) . . . Wgt. 0.56 oz.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
1,000-TZ	1,000	705	various
2,000-TZ	2,000	750	various
5,000-TZ	5,000	800	various
10,000-TZ	10,000	1,650	various
20,000-TZ	20,000	1,500	.00002
25,000-TZ	25,000	1,500	.00002
30,000-TZ	30,000	1,400	.00002
50,000-TZ	50,000	1,400	.00002
100,000-TZ	100,000	1,500	.00002

MODEL C HELIPOTS

Identical in general design to Model A except has only 3 helical turns of resistance winding and proportionately shorter length. Ideal for high-accuracy applications with restricted behind-panel depths.

3-turns . . . Power rating 3 watts . . . Coil length 13½" . . . Linearity tolerance ±0.5% (Std.) . . . Behind-Panel Length 1-9/64".*

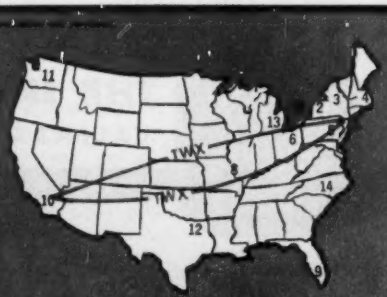
TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
10-CZ	10	1,000	.00071
50-CZ	50	1,390	.00071
100-CZ	100	1,100	.00002
500-CZ	500	1,850	.00002
1,000-CZ	1,000	1,360	.00013
5,000-CZ	5,000	2,500	.00013
10,000-CZ	10,000	3,100	.00013
20,000-CZ	20,000	3,900	.00013
30,000-CZ	30,000	4,400	.00013
50,000-CZ	50,000	4,250	.00013

***ON SPECIAL ORDER** most of the above potentiometers are available with Rear Shaft Extensions . . . Extra Spot Welded Taps at any location . . . Ganged Assemblies . . . Special Temp. Coefficients, Resolutions, etc.*

Write for details!

Engineering Sales Representatives are located near you to assure personal attention. Teletype connects our New York, Boston, Chicago and Los Angeles offices for rapid information on orders and deliveries. And our Mountainside, New Jersey plant, now under construction, will soon be in production to further assist you.



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Helipot

MODEL J HELIPOTS

First production potentiometer equipped with ball-bearing shaft supports as standard and 3-way servo-type mounting. Ganged assemblies can be independently phased after installation without external clamps or brackets.

1-turn . . . Power rating 5 watts . . . Coil length 5½" . . . 360° Cont. Mech. Rotation . . . Linearity tolerance ±0.5% . . . Starting torque 1.0 ± .25 oz. in.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-JZ	100	630	.00002
1,000-JZ	1,000	875	.00017
5,000-JZ	5,000	1,300	.00017
10,000-JZ	10,000	1,475	.00017
20,000-JZ	20,000	1,900	.00017
30,000-JZ	30,000	1,975	.00017
50,000-JZ	50,000	2,260	.00002

Please note that 400 volts is highest that may be applied across coil regardless of resistance value.

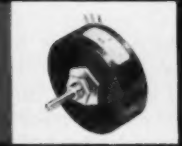
MODEL G HELIPOTS

A small, extra rugged single-turn pot developed initially for aircraft servo mechanisms. Its compact size, high accuracy, long life make it ideal for many instrumentation and servo-mechanism applications.

1-turn . . . Power rating 2 watts . . . Coil length 3¼" . . . 360° Cont. Mech. Rotation . . . Linearity tolerance ±0.5% (Std.) . . . Wgt. 2 Oz. . . . Dia. 1-5/16".*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
10-GZ	10	300	.00071
100-GZ	100	400	.00002
500-GZ	500	500	.00013
1,000-GZ	1,000	650	.00013
5,000-GZ	5,000	750	.00013
10,000-GZ	10,000	950	.00013
20,000-GZ	20,000	1,200	.00013



MODEL F HELIPOTS

A 3" dia. single-turn high-precision potentiometer with continuous mechanical rotation and minimum dead spot between electrical ends. Versatile in application. Ideal where continuous rotation simplifies circuitry.

1-turn . . . Power rating 5 watts . . . Coil length 9¼" . . . Linearity tolerance ±0.5%.*

TABLE OF STOCK VALUES

Catalog No.	Total Resistance (Ohms)	Wire Turns	Temperature Coefficient
100-FZ	100	800	.00002
500-FZ	500	1,300	.00002
1,000-FZ	1,000	1,200	.00013
5,000-FZ	5,000	2,000	.00013
10,000-FZ	10,000	2,500	.00013
20,000-FZ	20,000	2,700	.00013
50,000-FZ	50,000	4,000	.00013
100,000-FZ	100,000	5,000	.00002

Please note that 400 volts is highest that may be applied across coil regardless of resistance value.

NOT CARRIED IN STOCK but quickly available on order

MODELS AN and CN HELIPOTS

Mechanically precise, highly linear potentiometers of same general dimensions as Models A and C, except have servo-mountings, ball-bearing shafts and are built to highest precision possible. Have approximately 2:1 advantage in linearity accuracies over corresponding A and C Helipots. (Model AN linearity tolerances as close as ±.025% in values of 5K and above.)

AN (10-turns) resistance ranges, 100 to 250,000 ohms . . . **CN** (3-turns) 30 to 75,000 ohms.

Write for full details on linearity tolerances, special features, etc.

MODELS D and E HELIPOTS

Large diameter (3-5/16"), wide range Helipots with extremely long resistance windings for highest possible resolutions coupled with close linearity tolerances.

Model D has 25 turns, 234° coil length, 9000° of rotation, is 4-9/64" deep behind the panel, and is available in ranges from 100 to 750,000 ohms.

Model E has 40 turns, 373° coil length, 14,400° of rotation, is 6-1/64" deep behind panel, resistances 200 to 1,000,000 ohms.

Write for full details on linearity tolerances, special features, etc.

OTHER UNIQUE HELIPOT PRODUCTS

MODEL RA Precision DUODIALS

A beautiful, precision-built, multi-turn dial of compact dimensions (1-13/16" dia.) for all types of quality multi-turn installations. Features unique "jump" mechanism that keeps secondary dial stationary until primary dial has completed a full turn—then secondary dial "jumps" to new position. A vibration-proof lock holds dial settings whenever desired.

Black nylon knobs, satin aluminum dials, quality "feel" and appearance throughout. Available in 10-turn design for use with 3 and 10-turn Helipots and in RAJ version for use with small AJ Helipots.

Write for full details.

MODEL W DUODIALS

A large diameter (4¾") multi-turn dial ideal for primary control applications. The inner dial shows the exact position of the slider on any multi-turn Helipot while the outer dial shows the particular turn on which the slider is moving. Thus with 10-turn units, readings can be made directly in decimal equivalents of total resistance winding.

Since primary dial is direct-connected to shaft, backlash is eliminated.

Available in 10:1, 15:1, 25:1, and 40:1 Ratios for use with various Helipot models as well as with other multi-turn equipment.

Write for full details.

LABORATORY HELIPOT—MODEL T-10A

This unit combines in a handsome walnut case a 10-turn Helipot, an "RA" Duodial, and three-way binding posts for quickly setting up and changing experimental or temporary circuits. Ideal for laboratory and instruction purposes . . . is far more compact, simpler and 5 times faster to set than decade boxes.

Power rating 5 watts . . . Linearity 0.1% . . . Standard Resistance Ranges 100 . . . 500 . . . 1,000 . . . 5,000 . . . 10,000 . . . 20,000 . . . 50,000 . . . 100,000 ohms in stock. Other ranges on order.

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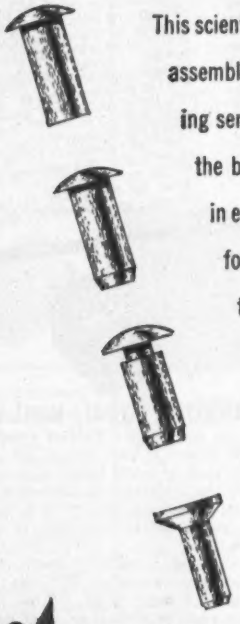

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an indication of the unbalance on the meter. The meter is adjusted to show the average of the pulses appearing at the output of the G-M tube.

Prediction of Electronic Failures

THE FAILURE of a tube or other component in an electronic device can happen suddenly or result from gradual deterioration. Possibility of sudden failure can be reduced only by improvement in design, but the nature of gradual deterioration makes possible the detection of a failing component before it becomes inoperative.

Detection of incipient failure in multistage equipment by input-output measurements is unreliable. Tolerances in overall measurements may mask changes caused by deterioration of a tube in one stage, and the point at which deterioration becomes detectable may practically coincide with the failure point. In order to make successful predictions a means of testing individual stages is necessary.

A technique developed experimentally by the National Bureau of Standards permits an unskilled maintenence man with a portable failure-prediction unit to test slightly modified equipment for failing components. The prediction unit includes a 3,000-cycle oscillator, voltage sensing circuits, a leakage detection circuit and an alarm light.

Measurement Procedure

In use, the unit is plugged into the device being tested and a multi-

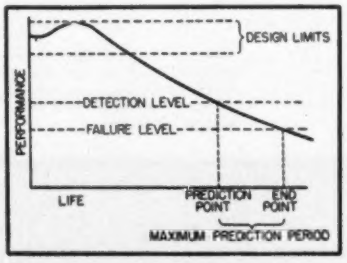

FIG. 1—Chart showing deterioration in performance during life of component. This type of curve is applicable to many types of components including tubes, resistors, capacitors or complete subassemblies

Cramer TIMING DEVICES

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MODEL ET

better than
0.02 of 1%
accuracy

Designed to the most exacting specifications for such applications as timing operations in industrial laboratories or for measurement processes in the chemical and metals industries. Incorporates new principle of differential clutching that prevents slippage and overrun and insures unusually high accuracy and dependable performance.

FEATURES

- *High Accuracy*... Better than 0.02 of 1% of full scale reading.
- *Positive Clutching*... Differential gear clutch provides positive action. No friction element to slip or wear. Accuracy further improved by clutching at a high-speed part of the gear train.
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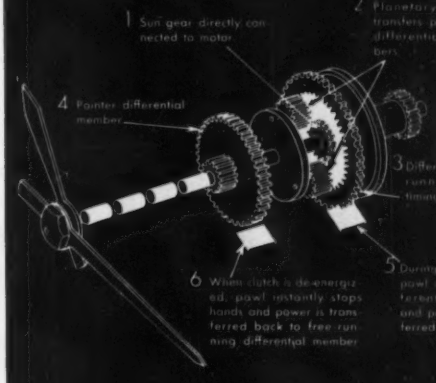
- *Easy-to-Read Dial*... Large sweep hand permits extremely precise readings.
- *Compact Size*... Takes up minimum space on crowded panels... ideal for portable or airborne equipment.
- *Military Specifications*... Models available to meet exacting specifications as to shock, vibration, temperature, etc.

POSITIVE ACTION CLUTCH
WITH DIFFERENTIAL GEAR
PREVENTS SLIPPING OR OVERRUN


1 Sun gear directly connected to motor
2 Planetary system transfers power to differential members
3 Differential member free running except during timing cycle
4 Pointer differential member
5 During timing cycle, pawl stops this differential member and power is transferred to pointer
6 When clutch is de-energized, pawl instantly stops hands and power is transferred back to free-running differential member

In this unique clutch mechanism, the motor is permanently connected to the sun gear of a differential gear system. A solenoid pawl moves between the two differential members so that only one is free to rotate at one time. Starts and stops are thus effected by positive engagement of pawl with gear. There can be none of the slippage or overrun associated with friction clutches; nor can characteristics change with age.

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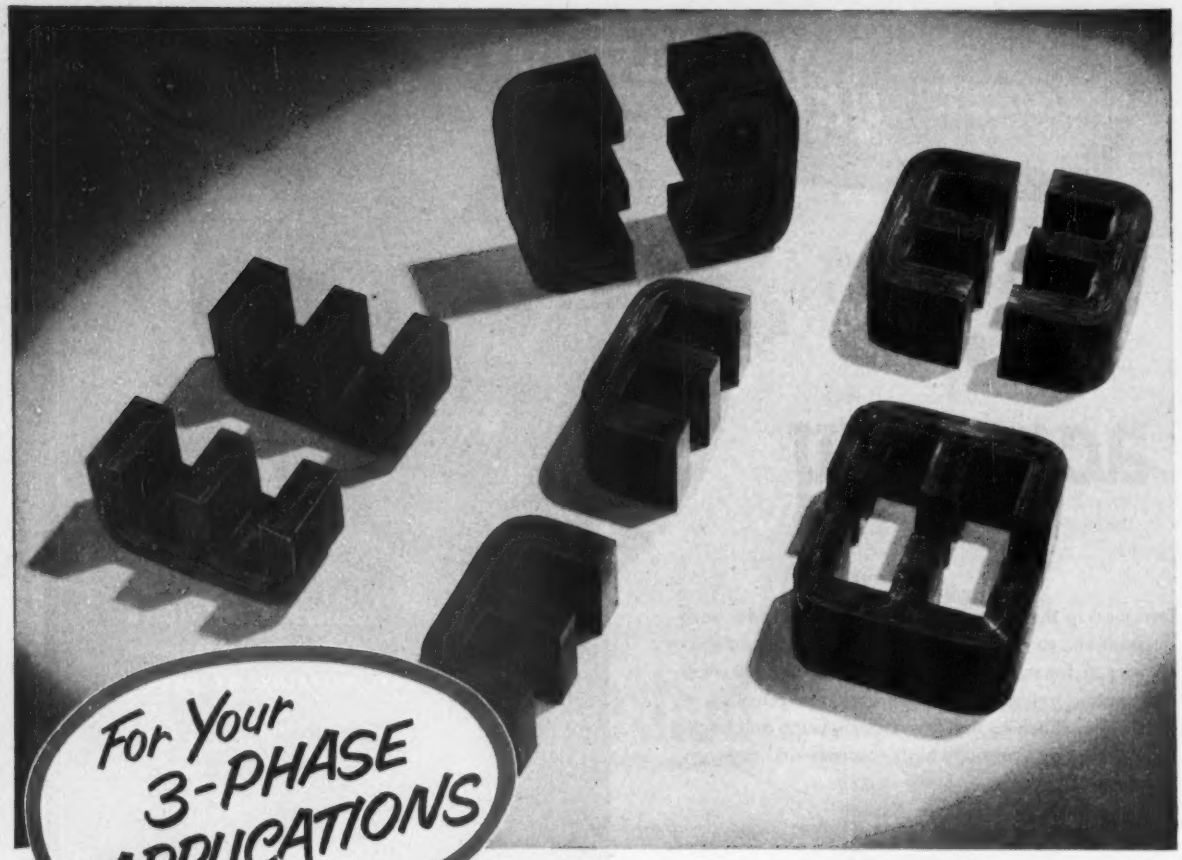

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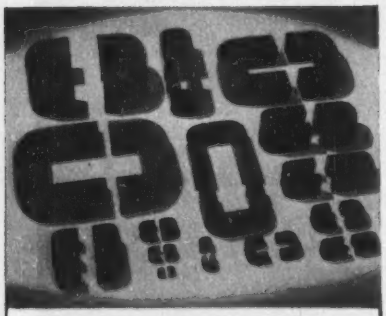
Arnold E-CORES



C-Cores to meet any requirement

For your single-phase applications, Arnold "C"-Cores are available in any shape and quantity, and in any size from fractions of an ounce to hundreds of pounds . . . wound from Silectron strip in a wide range of ultra-thin and heavier gauges. (Sizes up to 10 lbs. in 12-mil strip; to any weight in thinner gauges.)

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position switch is used to connect the tester with individual stages. Audio signals of different predetermined levels are applied to the grid of each stage. Each of the input signals is preadjusted so that the voltage-sensing circuit will actuate the alarm light if the gain of the stage has decreased by more than the safe amount. A separate three-position switch on the test unit allows capacitor-leakage sensing and voltage-and-current sensing, in addition to gain sensing.

In electronic equipment, the most common cause of failure is defective tubes. The failure predicting unit operates by sensing the decrease in transconductance of tubes in critical stages. To do this, the tube is operated as a resistance-coupled amplifier. A 3,000-cycle signal is applied and the sensing unit determines if the gain has fallen below the predetermined limit. Defects in components other than tubes will be detected by this test if their change affects the gain of the stage.

In developing the failure-prediction unit, six 18-stage military receivers were modified to permit insertion of the audio signal and measurement of gain. The receivers were then subjected to a 1,000-hour accelerated aging test. Temperatures were cycled between 10 C and 120 C with a total period of fifteen minutes. Voltages were maintained at 15 percent above design values and plate voltages were raised periodically to 150 percent of normal for one second, to simulate switching transients. Prediction checks were made every five hours.

In the thousand-hour test period, 79 tube failures occurred in the six 11-tube receivers. Of these failures, 65 were of the gradual and predictable type. There were 14 open and short circuits, six of which occurred during a 60-hour period when heaters and plates were cycled one minute on and one minute off. The other eight failures were spread over the remaining 940-hour period.

Of the 65 predictable failures, 58 were accurately predicted many hours before the receiver failed. Of the seven predictable failures not successfully predicted, four were in

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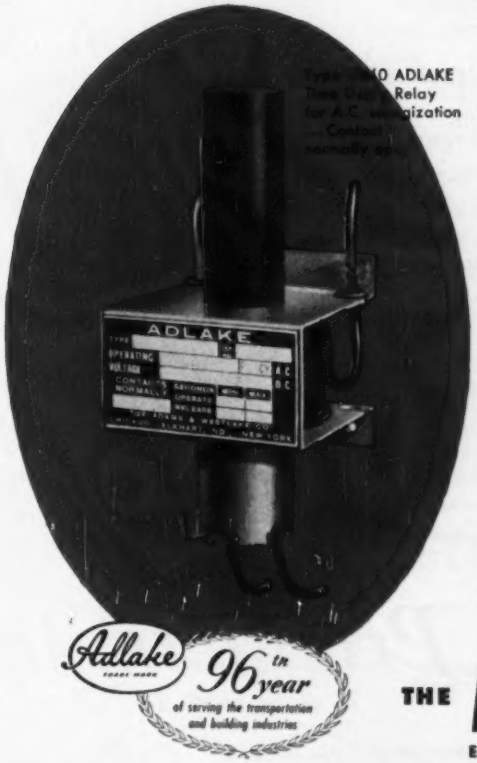

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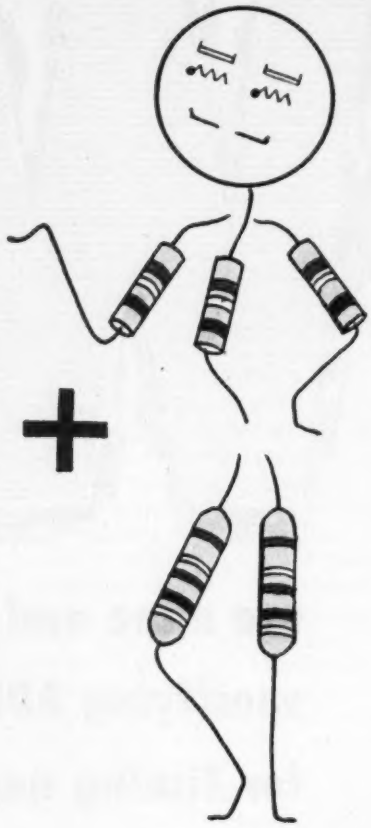

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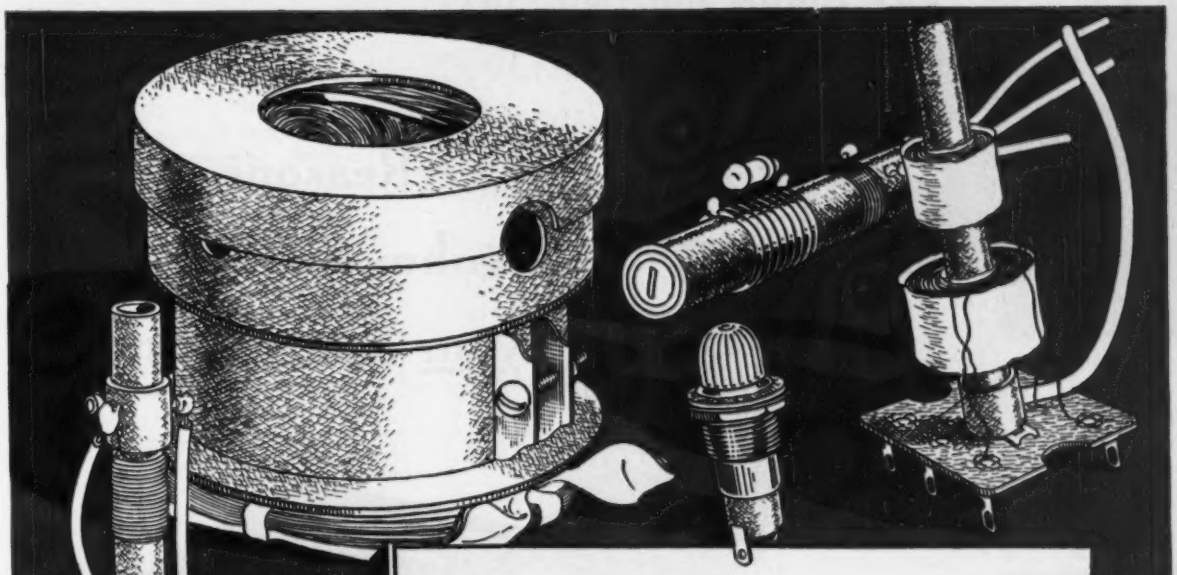

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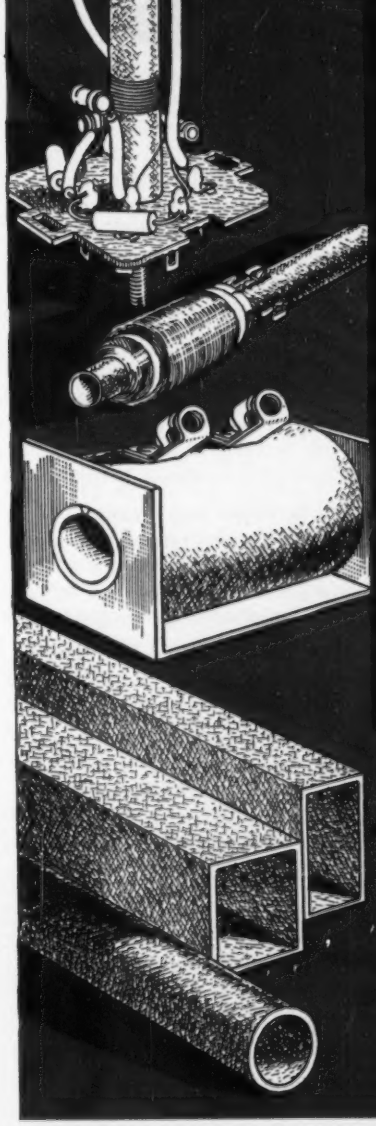

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a single stage where parasitic oscillations interfered with measurements, one was masked by a change in value of an overloaded resistor and four were in stages not being checked. Failures in components other than tubes were negligible.

Although the principles on which this experimental work is based are not new, the success of the tests indicate that practical failure-prediction systems can be devised and that provisions for such systems should receive the serious attention of design engineers.

Milled Block Simplifies Microwave Construction

BY USING WAVEGUIDES cut in blocks of conductive material it is possible to reduce the bulk and complexity of microwave circuits. Sharper curves without spreading of the waveguide walls, and reduction of reflection losses in fitting mechanical components are also possible by this method.

Developed by Ferranti, Ltd., the circuit is made up of two mated milled blocks. Each block has rectangular channels half the width of the major dimension of the waveguide. When joined together the channels coincide to form complete waveguide and duplexer circuits. Guideways for t-r cells, crystals or probes can be milled where required.

The fact that the waveguides are divided through their centerline has no effect on electrical performance, and is convenient for

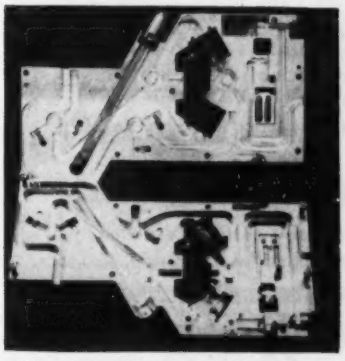

FIG. 1—Complex waveguide circuit cut in metal block. Spaces in block allow mounting of other components

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Amperes, DC: 10
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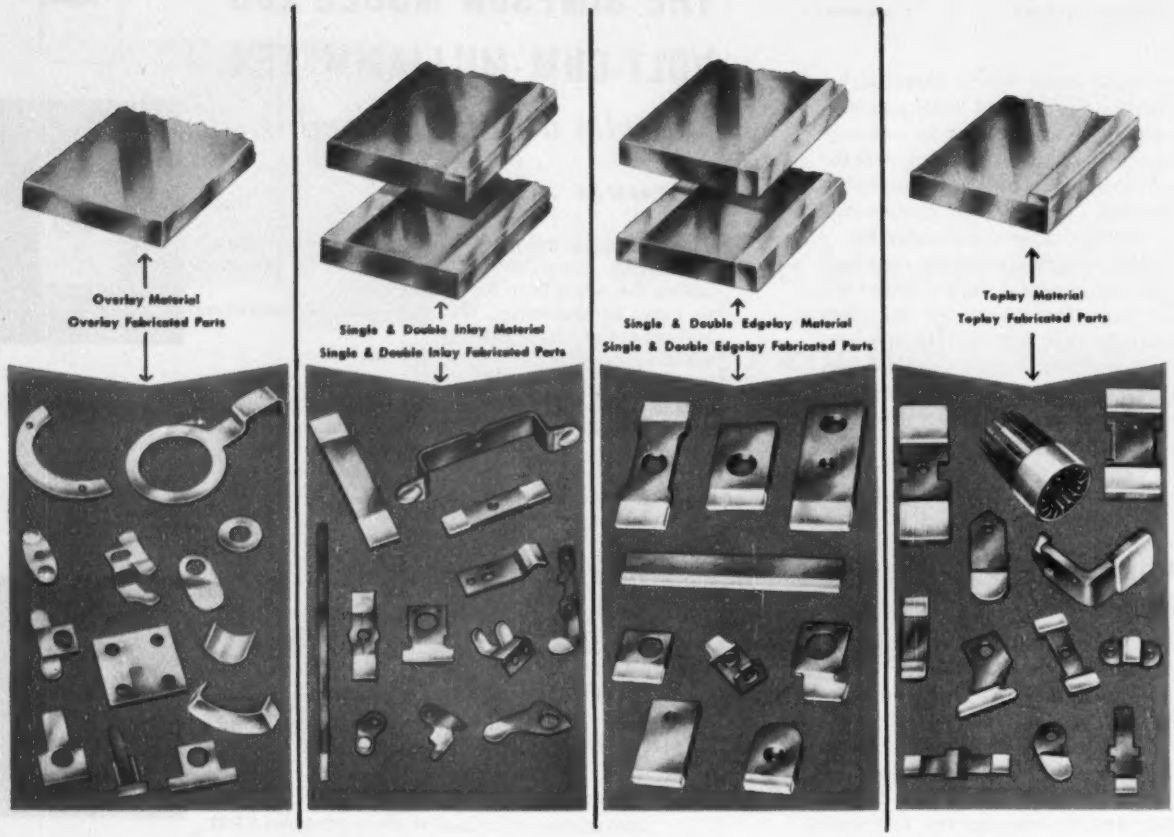
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For more information on the new G-E Drawn-oval capacitors, their ratings, dimensions and prices, see your local G-E apparatus sales representative or write for Bulletin GEA-5777. Address Section 407-311, General Electric Company, Schenectady 5, N. Y.

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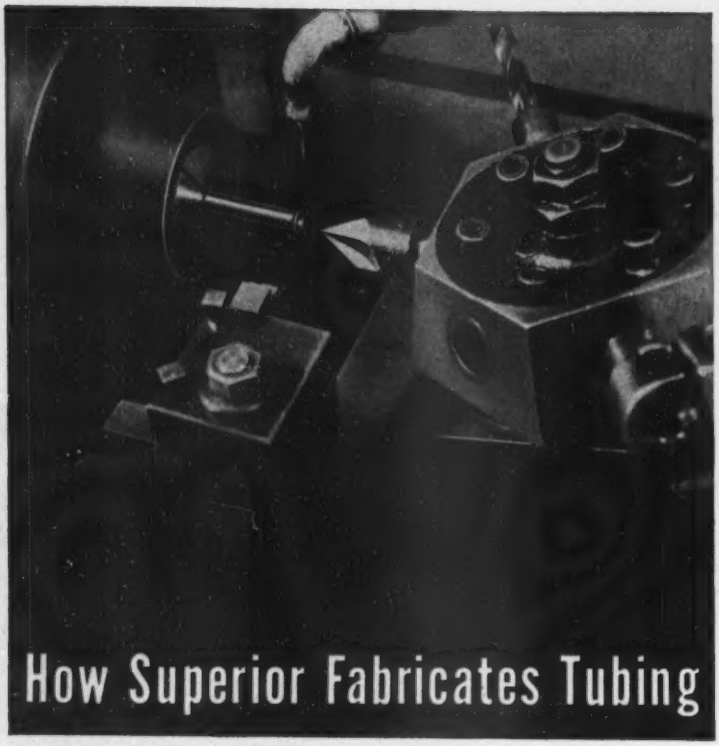

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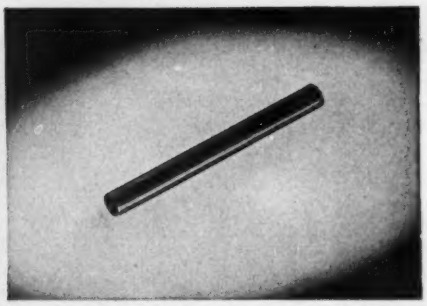

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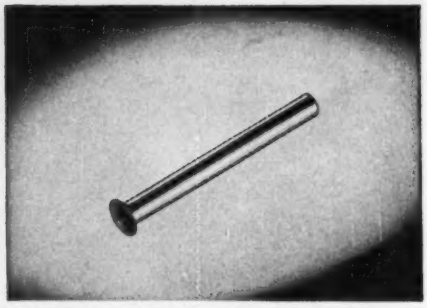

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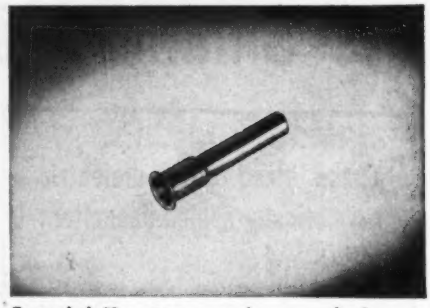

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internal inspection of the guides or insertion of attenuator wedges and other r-f components.

Time required for manufacture of circuits by this method is about one third of that required to make up a conventional waveguide assembly. The solid construction provided by the milled block technique allows the use of the block as a mount for other circuits. Amplifiers for r-f and i-f can be plugged directly into the block, eliminating the need for flexible leads.

Resistances for Symmetrical T and H Pads

CALCULATION OF RESISTANCES used in T or H pad attenuators for a given amount of attenuation can be simplified by the use of Table I. For a symetrical T pad, the values of R_1 and R_2 can be found by multiplying the impedance that the pad should have by the value in the table for the desired attenuation, according to the *Lenkurt Demodulator* for Nov. 1952.

For example, to construct a 600-ohm T pad with 10-db attenuation, the resistance values are as follows: R_1 is equal to 600 times 0.5193 or

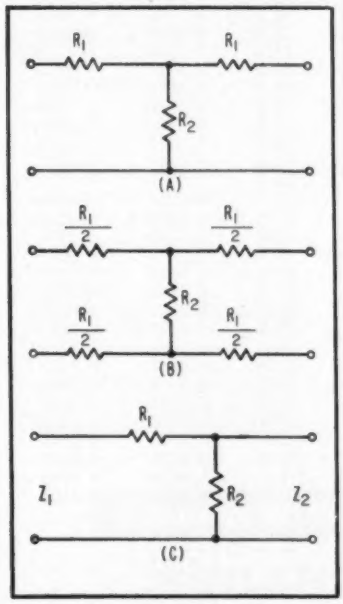
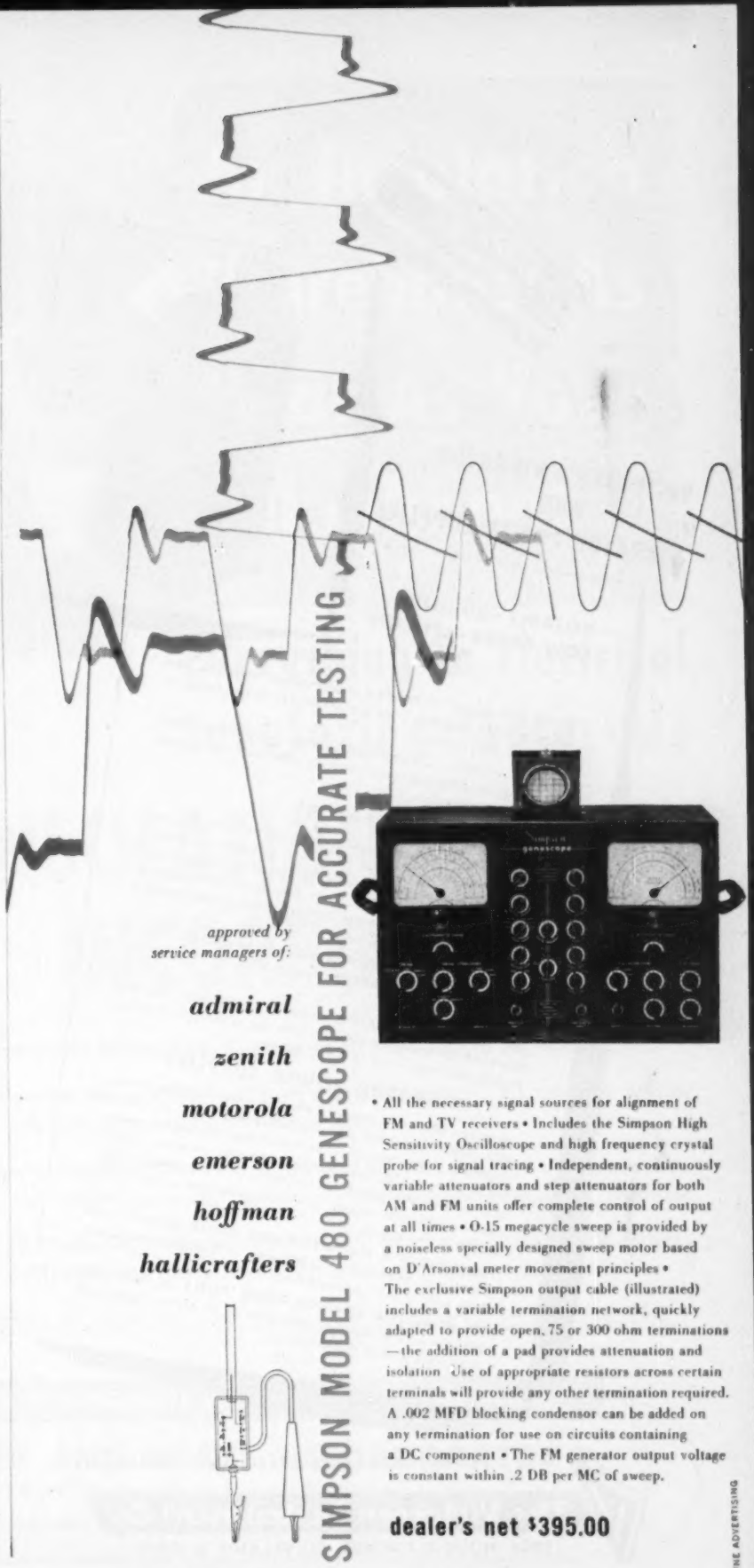


FIG. 1—Values of resistors for T-type (A), H-type (B) and low-loss L-type (C) pad attenuators can be determined from Table I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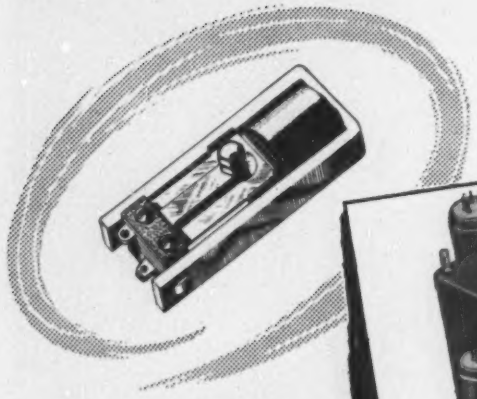

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The precision vibrators, used in these power supplies, are available as separate units. They are mounted in sponge rubber and hermetically sealed in a convenient plug-in unit. Proven applications include: high voltage power supplies, scintillation counters, portable Geiger counters, and portable radios. Net weight is 2½ ounces.

THE MODEL 531 VIBRATOR is designed to operate from a 1.5 or 1.3 volt battery and requires as little as 18 milliwatts driving power.

THE MODEL 542 VIBRATOR is also an 18 milliwatt unit, but designed for operation in series with the primary of a transformer and from a 4.5 to 6-volt battery.

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Victoreen offers two standard vibrator power supplies for use with battery-operated portable equipment such as Geiger counters, photo-multipliers, and electronic equipment requiring a high voltage supply. These compact units are potted and hermetically sealed for reliability and ruggedness. They contain regulator circuits to insure stabilized outputs. Net weight is one pound.

THE MODEL 517 VIBRATOR POWER SUPPLY operates from 4.5 volts dc and supplies +900 volts at 5 microamperes and +58 volts at 0.25 milliamperes.

THE MODEL 532 VIBRATOR POWER SUPPLY operates from 3.0 volts dc and supplies −900 volts at 15 microamperes and +58 volts at 0.25 milliamperes.

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311.58 ohms; R_2 is equal to 600 times 0.7031 or 421.86 ohms. If an H pad were required, the values of the line resistors would be half the values of R_1 and R_2, as shown in Fig. 1.

Pi and O-type pads are equivalent electrically to T and H pads and are ordinarily used when the resistances required are more easily ob-

Table I—Resistance and Loss Values

db	Multiplier for R_1	Multiplier for R_2
0.5	0.0287	17.3775
1.0	0.0575	8.6680
1.5	0.0861	5.7620
2.0	0.1147	4.3037
2.5	0.1429	3.4270
3.0	0.1712	2.8357
3.5	0.1987	2.4168
4.0	0.2263	2.0963
4.5	0.2532	1.8483
5.0	0.2801	1.6453
5.5	0.3060	1.4808
6.0	0.3322	1.3389
6.5	0.3573	1.2206
7.0	0.3825	1.1158
7.5	0.4065	1.0267
8.0	0.4304	0.9466
8.5	0.4536	0.8756
9.0	0.4764	0.8112
9.5	0.4981	0.7547
10.0	0.5193	0.7031
10.5	0.5403	0.6552
11.0	0.5604	0.6119
11.5	0.5798	0.5724
12.0	0.5984	0.5364
12.5	0.6169	0.5021
13.0	0.6344	0.4710
13.5	0.6516	0.4416
14.0	0.6672	0.4158
14.5	0.6830	0.3905
15.0	0.6983	0.3668
15.5	0.7126	0.3453
16.0	0.7264	0.3251
16.5	0.7399	0.3058
17.0	0.7528	0.2878
17.5	0.7647	0.2715
18.0	0.7765	0.2556
18.5	0.7876	0.2411
19.0	0.7982	0.2273
19.5	0.8084	0.2143
20.0	0.8182	0.2020
20.5	0.8275	0.1905
21.0	0.8363	0.1797
21.5	0.8448	0.1683
22.0	0.8528	0.1599
22.5	0.8605	0.1508
23.0	0.8678	0.1423
23.5	0.8747	0.1343
24.0	0.8813	0.1267
24.5	0.8876	0.1195
25.0	0.8935	0.1128

$$R_1 = R_0\left(\frac{x-1}{x+1}\right)$$

$$R_2 = R_0\left(\frac{2x}{(x-1)(x+1)}\right)$$

$$x = 10^{db/20} = 10^{0.05db}$$

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tained than those for a T or H pad. Most handbooks have formulas for conversions between the two types.

Resistance values for minimum-loss L pads can be obtained from the table by the use of the following formulas.

$$R_1 = Z_1\sqrt{1-\frac{Z_2}{Z_1}}$$

$$R_2 = \frac{Z_2}{\sqrt{1-\frac{Z_2}{Z_1}}}$$

Echo Box Provides Target for Radar Training

By Lt. Robert A. Latimer
Connally AFB
Waco, Texas

Using an echo box to reflect radar waves, a target trainer in use at Connally Air Force Base, Texas, simulates airborne targets on radarscopes in ground school classrooms. The device allows students to become familiar with target tracking operations before making actual training flights.

The synthetic trainer is powered by two 28-volt motors mounted on a trolley that rides a curved track on a narrow table. One motor is geared to the drive wheels of the trolley and the other is used to move the echo box on a five-foot vertical rod. By varying the speed of the motors the position of the echo box

FIG. 1—Target simulator used in radar training. Echo box at lower left reflects radar waves to give same scope pattern as a plane in flight

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9M11	8.7	1.8	9	1-7/32
15M11	14.2	2.3	15	1-13/32
20M11	19.6	2.7	21	1-37/64
DIFFERENTIAL				
6MA11	5.0	1.5	7	1-7/64
9MA11	8.7	1.8	13	1-7/32
15MA11	14.2	2.3	22	1-13/32
19MA11	19.6	2.7	31	1-37/64
BUTTERFLY				
3MB11	3.1	1.5	7	1-7/64
5MB11	5.1	1.8	13	1-7/32
9MB11	8.0	2.2	22	1-13/32
11MB11	10.8	2.7	31	1-37/64

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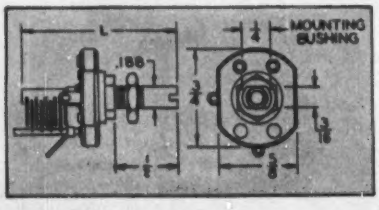

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Negative Resistance Crystal Oscillators

BY SERGIO BERNSTEIN

Government Division
Fada Radio and Electric Co. Inc.
Belleville, New Jersey

THE FREQUENCY stability of a crystal oscillator is affected essentially by variation of the quartz crystal properties, variations of the oscillator tube parameters, and Variation of the associated circuit parameters (R, L, C). Modern crystal cutting and mounting techniques have produced crystals whose frequency stability is very high. Thus changes occurring in the associated oscillator circuits are by far the greatest factors affecting the frequency stability.

A new circuit is presented here in which the circuit constants comprise only resistances. These resistances may have extremely small temperature coefficients by using special wire (such as manganin) and can be made noninductive by special winding methods.

Essentially the oscillator circuit comprises a piezoelectric crystal, driven by a vacuum tube connected so as to present a negative differential transconductance to the crystal terminals. Two possible meth-

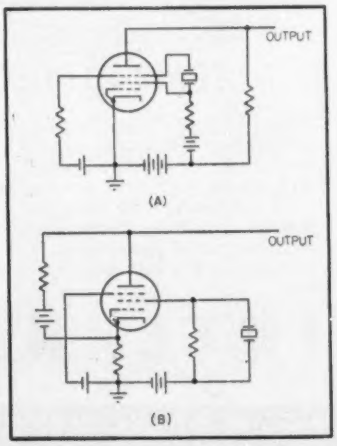

FIG. 1—Two crystal oscillators using only resistances as circuit components

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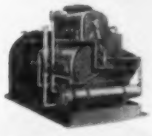

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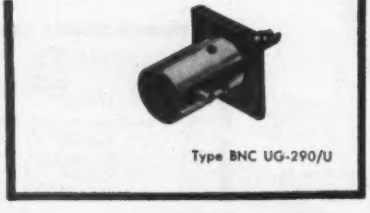

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ods of connection are shown in Fig. 1A and B. The first method of connection has a practical advantage over the second, since all the voltages can be derived from taps on a single power supply.

Another property of this type of crystal oscillator is that it is possible to make the frequency of oscillation of the system exactly coincident with the mechanical resonant frequency of the crystal. It is also possible to obtain small frequency changes by shunting very small capacitances across the crystal. To prevent appreciable changes in the figure of merit of the quartz crystal, these shunting capacitances should be on the order of 0.1 $\mu\mu$f.

Variation of tube parameters can be reduced to extremely small values by the proper choice of applied potentials. Moreover, if all the voltages are obtained from a common voltage divider, these variations will be practically nullified through a self compensating action.

When extreme frequency stability is desired, it is important to insure that the operating point coincides with the point of inflection of the negative transconductance characteristic. This precaution has to be taken to obtain the best possible excitation voltage waveform, since any distortion in the exciting waveform will modify the oscillation frequency of the system.

Experimental results obtained with a 100-kc crystal oscillator has shown that it is possible to make the oscillator frequency coincide exactly with the mechanical resonant frequency of the quartz crystal. Variation of $\pm$ 5 percent of any or all of the applied voltages caused frequency variations of less than 1 part in 10^8.

Vehicular Communications Symposium

TECHNICAL PAPERS presented before 250 engineers at Washington, D. C. in early December outlined problems in the growth of mobile radio communications, particularly at vhf. Sponsored by the Professional Group on Vehicular Communications of the Institute of Radio Engineers, the meeting concentrated upon spectrum-conservation meas-

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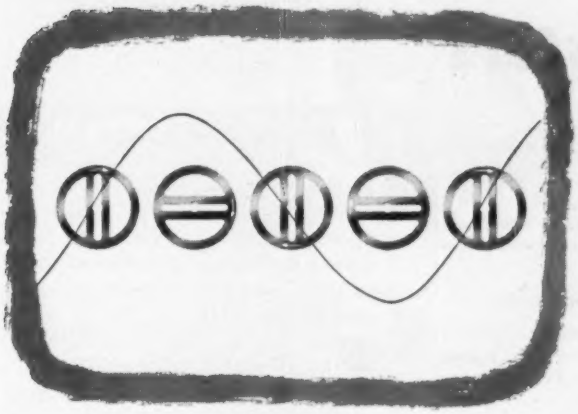

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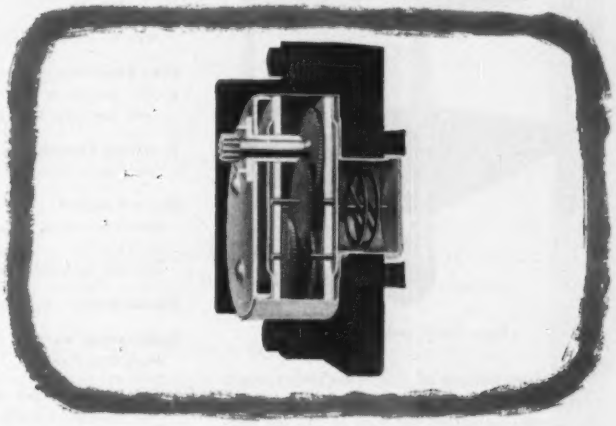

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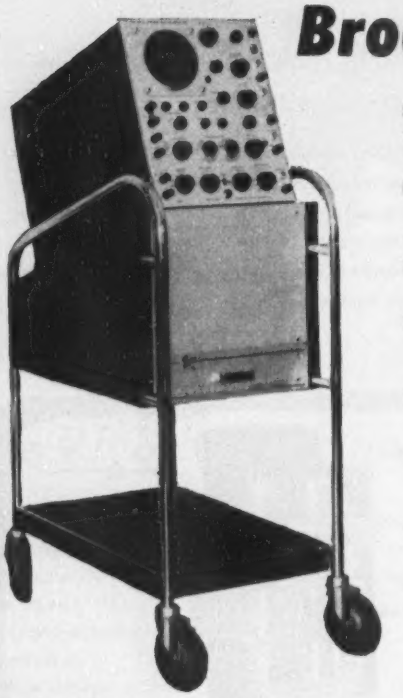

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ures. Emphasis was placed upon channel-splitting because the Federal Communications Commission in late 1951 had requested the Joint Technical Advisory Committee to study the feasibility of this technique, already demonstrated at 50 mc.

Field Experience

Early tests were described by W. M. Rust, Jr. of Humble Oil Co. and J. S. Stover, Communications Engineering Co. With a total of 20,000 petroleum stations now in operation and an increase of 5,000 a year predicted, tests were begun in 1951 using f-m receivers accepting a bandwidth of 20 kc and transmitters having a deviation of ±5 kc. Under conditions of normal noise, communications were good when an interfering station operated as close as 5 miles away. However, when receiver bandwidth was reduced to 17 kc, the interfering signal required displacement of 8 miles to re-establish comparable service. Interference from signals in adjacent bands is about the same using either wide-band or narrow-band techniques. Although the overall stability of the modified equipment has proved good, the narrow-band sets require careful maintenance.

Extensive field tests by RCA of mobile equipment having reduced receiver bandwidth and narrower transmitter deviation ratios were described by H. E. Strauss. For these tests, equipment stability was held to values such as ±0.0005 percent for receiver and transmitter oscillators. Three bandwidths were employed for systems of 60, 30 and 20 kc with transmitter deviation ratios of ±15, ±6 and ±3 kc respectively. In addition, other deviations were sometimes employed that just filled the receiver bandpass at the 6-db point. It was established that narrow-band equipment was more susceptible to noise than wide-band equipment, but that the amount of degradation caused by impulse noise had to be determined by field tests.

The JTAC tests conducted by a number of manufacturers at Syracuse, N. Y. during late October

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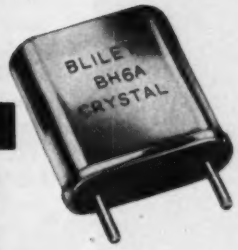

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Military types CR15, CR16, CR18, CR19, CR23, CR24, CR27, CR32, CR36, CR47 are representative of current production by Bliley. Complete range of types and cross reference index is given in Bulletin 43.

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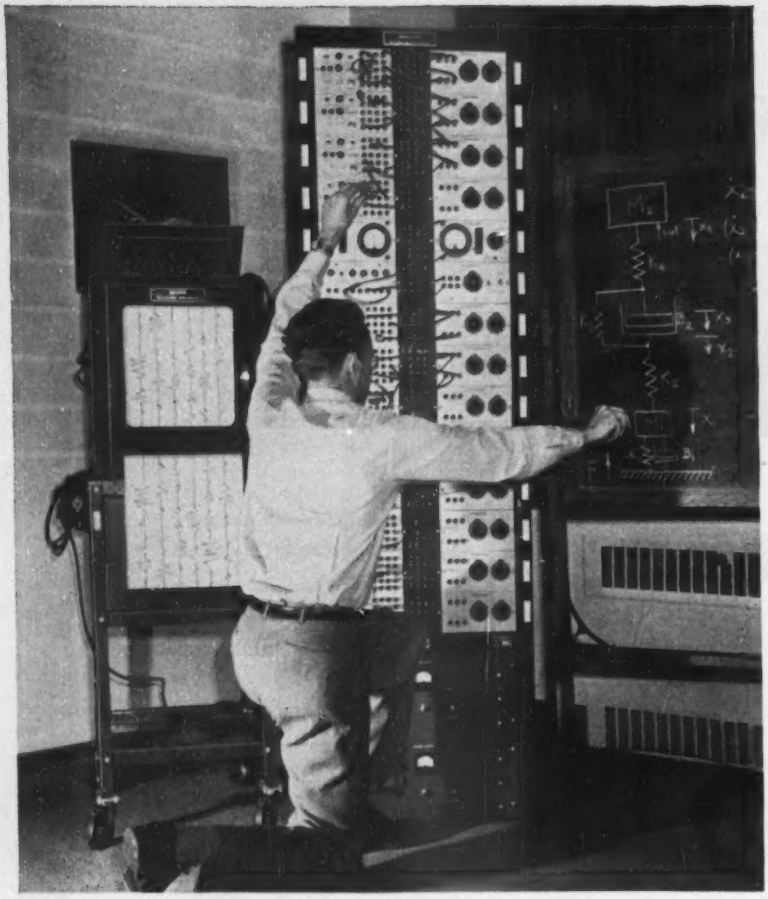
were summarized by N. H. Shephard of GE who played back tape recordings showing comparisons of fringe-area signals employing a variety of systems characteristics. Receivers used were wide-nose (±15 kc), and narrow-nose (±5 kc) types, while the transmissions were characterized as wide-band (±15 kc), narrow-band (±5 kc) and narrow-band-filter types. In the latter, deviation was held to ±5 kc and the audio signal limited to 2,500 cycles.

Field tests included those of range comparison and adjacent-channel interference under varying proximity of the undesired signal. The latter tests bear importantly upon what changes will be necessary during the probable transition from present standards and older equipment to those employing narrow-band receivers and transmitters.

D. E. Noble described the operation of a year-old Miscellaneous Common Carrier serving about 100 mobile customers at Phoenix, Arizona. Standard ±15-kc deviation equipment modified for ±5 kc is used on a split-channel basis. The land station is located 30 miles from the city atop White Tanks Mountain. Included in the system is a two-way microwave link for control of car-to-car relaying. With this system, two mobile units a mile apart can be interconnected to communicate over a circuit that may be 120 miles long. In general, however, relaying is accomplished at the mountain and is seldom returned through the city operating room so the circuit is 60 miles. Mobile equipment is provided with selective calling that gives a busy signal to the car and locks out its transmitter.

Filters suitable for use in mobile channel selection were discussed by two engineers. L. J. Labrie of Bell Telephone Laboratories described a new AT-cut crystal with a single resonant response. The circular faces of this crystal are of lesser diameter than the maximum diameter of the quartz button, with a radius of curvature five times that of the face between each face and maximum diameter. Operating in a



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thickness shear mode, the new crystal filter also requires special electrodes. Milton Dishal of Federal Telecommunication Laboratories, discussing the best filter with reference to a required i-f selectivity, analyzed L-C, mechanical and crystal devices. He showed that the coil-capacitor combination is not fundamentally inferior to newer types that are currently being recommended.

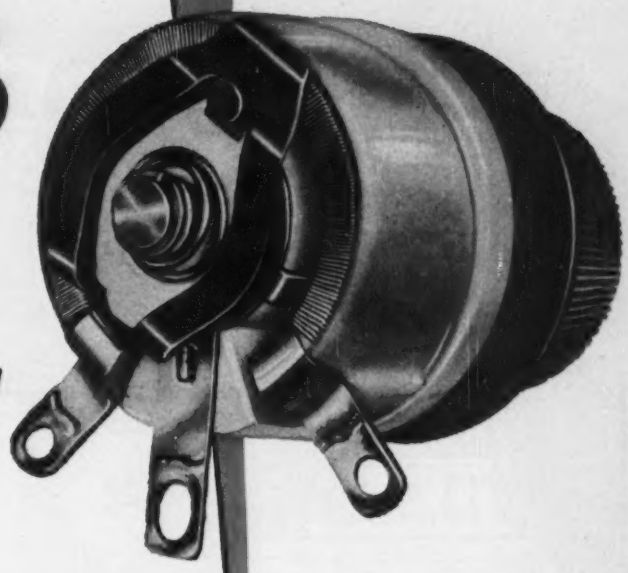
D. M. Heller of Bendix Radio and Kenneth Bullington of Bell Labs considered systems aspects of improved mobile communications. Mr. Heller showed that equipment using crystal control with an accuracy of 0.003 percent can be improved to 0.0006 percent by addition of simple temperature control. He suggested removing the residual i-f response error by improved mechanical design or temperature compensation indicating that characteristics of ± 1 kc per mc of mean frequency of the i-f over a range from -40 to $+60$ C is possible.

Mr. Bullington's paper covered in detail the necessary considerations of a coordinated system for a large metropolitan area wherein all high-power land stations would be located near a common point—within a mile of each other. By employing automatic gain control on the mobile receivers, all nearby signals could be fairly equally attenuated, whereas at a distance intermodulation effects of undesired signals will be too weak to cause interference. Base transmitters will require r-f filters for interference falling outside the bands employed in the coordinated system, but these can be installed easily at a base station.

Coordinated reception is not possible. Mobile power should therefore be cut to two or three watts (decreasing drain on the car battery) and multiple base receivers employed. While this has some disadvantages, it provides space diversity reception, which is good. In this system, guard bands will be needed at the system frequency extremities, but the sum total of spectrum required will be less because interchannel guard bands can be extremely narrow if not entirely eliminated. The alternative

The NEW rugged A-25

"Built to take it"



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The wound ring is made an integral part of the refractory base by vitreous enamel. The phosphor bronze actuating arm, to which is attached a graphite brush, gives perfectly smooth action, with excellent electrical control. And the shafts are insulated from all live parts by a strong shaft insulator.

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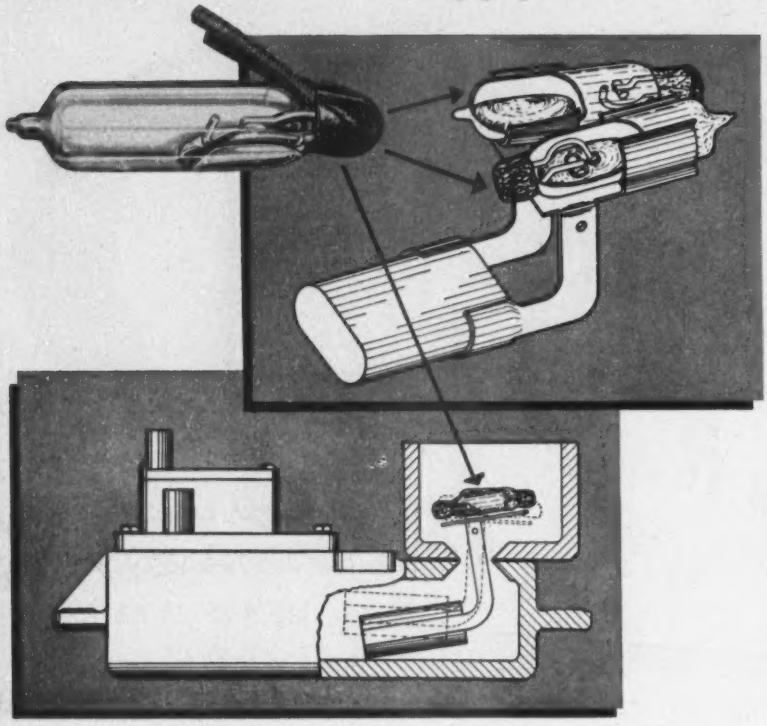
How two HONEYWELL Mercury Switches are used to shut off motor when oil supply is too low



HONEYWELL mercury switches meet the demands for low operating force and have the additional advantage of contacts being sealed in a glass case, protected from effects of oil fumes.

Problem of the designers of a pressure lubricating device was how to use low operating force to signal the operator when the supply of oil in the reservoir became low and . . . if oil was not replenished immediately . . . to shut off the motor.

The solution was found by attaching two HONEYWELL mercury switches to a float in the reservoir. When the level dropped to where the reservoir needed refilling, movement of the float actuated one switch to turn on a warning light. If the level became dangerously low, the float movement actuated the second switch to stop the machine.

HONEYWELL mercury switches have been recognized for 30 years as precise, dependable components for many types of switching controls. MICRO field engineering service, fully experienced in every type of switch problem, is available to assist you in the choice of the proper HONEYWELL mercury switch to meet your needs. Call your nearest MICRO branch office.

MICRO A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

MAKERS OF PRECISION SWITCHES

FREEPORT, ILLINOIS

to such system coordination appears to be a limit of ten or a dozen stations for each 10-mc slice of spectrum.

Comparison of mobile radio transmission at 150, 450, 900 and 3,700 mc was made in a paper by W. R. Young and read by his colleague, Walter Strack of Bell Labs. It was shown that 450 mc is a transmission medium superior in urban and suburban areas to the presently used 150-mc band. A broad optimum of performance falls in the region of 500 mc. While higher frequencies are less desirable, 900 mc is somewhat more effective than 150 mc if antennas with gain properties are employed. At 3,700 mc carrier-level fluctuations occur at an audible rate as the mobile unit progresses, impairing the use of this frequency. Frequencies above 1,000 mc can be used in this service but present difficulties.

E. N. Singer from the New York office of FCC pointed out the function of his group in running down complaints of adjacent and co-channel interference. To determine exactly the operation of mobile equipment a portable spectrum analyzer is being developed in the laboratories at Laurel, Md.

—A. A. MC K.

Suppressor Grid Control of Thyratrons

By H. L. Armstrong
National Research Council, Canada
Ottawa, Canada

OFTEN THE SIMPLEST way to control the current supplied to a load is to provide d-c to the load by a thyratron used as a rectifier in series with an a-c supply, and to vary the conduction period by varying the time of firing of the thyratron. This

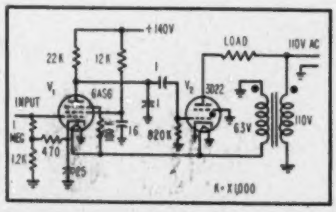


FIG. 1—Diagram of thyratron control circuit using out-of-phase suppressor grid voltage as trigger control

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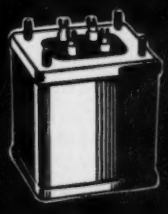

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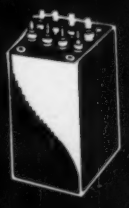

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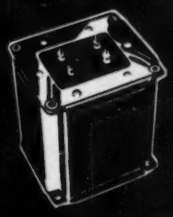

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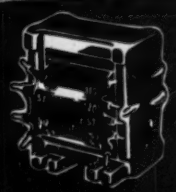
A precision electronic megohmmeter which for years has given satisfactory service in hundreds of laboratories and on production lines.

- **EASY TO READ**
  Direct reading on a 4" scale.
  Protected against overload.
- **RAPID & SAFE TO USE**
  Test voltage removed from terminals and capacitive components discharged to ground in all positions of multiplier switch.
- **ACCURATE**
  Within 3% up to 100,000 megohms, 5% from 100,000 to 2,000,000 megohms.

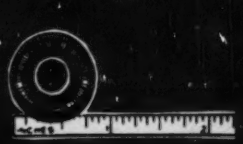
SPECIFICATIONS

Range: 1 megohm to 2,000,000 megohms in six overlapping ranges selected by a multiplier switch.
Voltages on Unknown: The voltage applied to the unknown terminals is 500 volts d-c and is independent (less than 1%) of the value of the unknown.
Stability: Line voltage variations from 105-125 volts will cause less than 2% variation in the meter reading.
Power Supply: 105-125 volts A.C. 50-60 cycles 30 watts.
Dimensions: 9½ x 10½ x 8 inches.
Net Weight: 18 pounds.

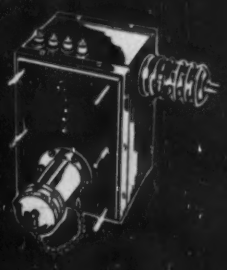
Sub-miniature hermetically sealed Toroidal Inductors



Freedseal Treatment ANE-19 Specs



Miniature Inductors



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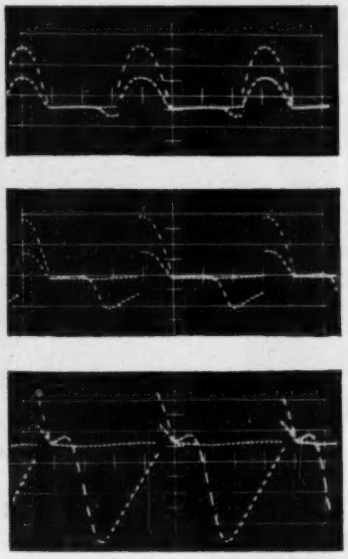
RECTIFIER DIVISION

Dept. E-1, 415 North College Ave., Bloomington, Indiana

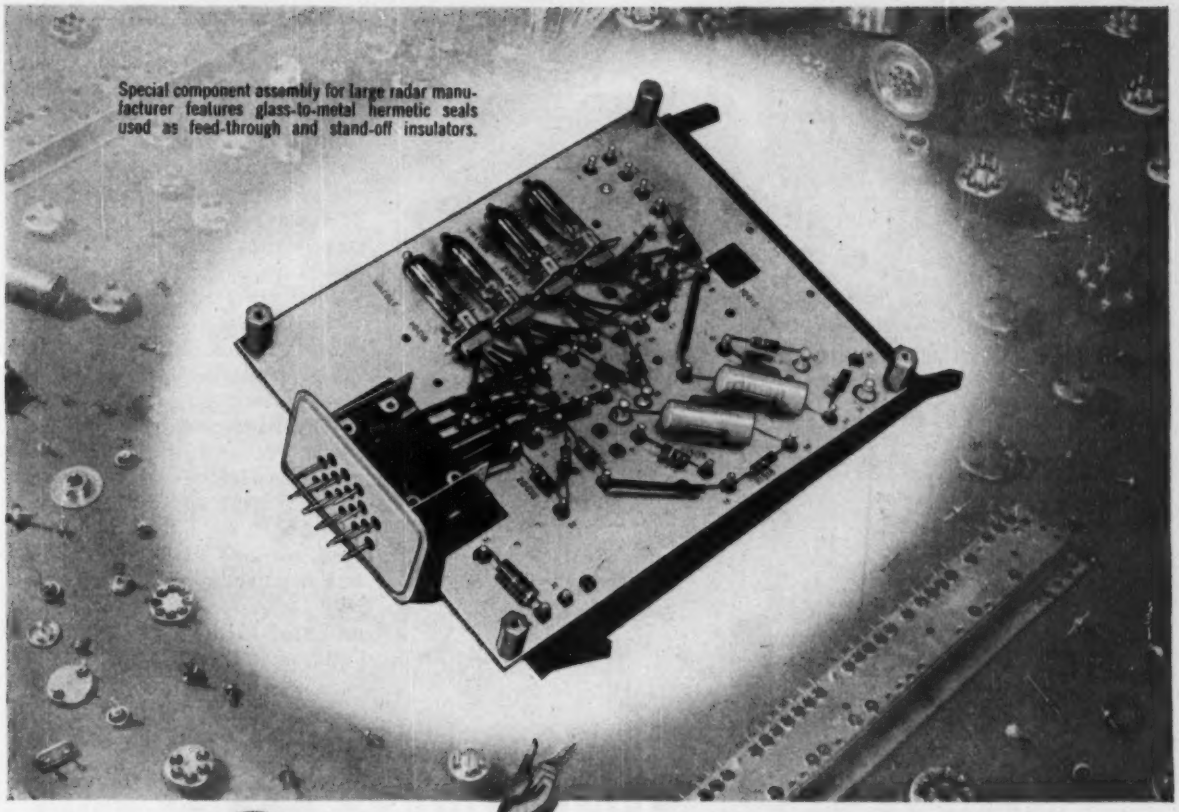
is accomplished usually by some combination of variable bias, and a-c 90 deg out of phase with the plate, applied to the grid of the thyratron. When the control must be accomplished by electronic means, variable bias can become difficult. The circuit described below and shown in Fig. 1 has been found to be simpler in some applications.

The idea is that the transformer is arranged so the voltage supplied to the plate of V_2 is 180 deg out of phase with that at the suppressor of V_1. Since the suppressor on a 6AS6 can cut off the plate current quite easily, V_1 draws current only during the negative peak of voltage



(A) The effects of negative grid swing (lower wave) on conduction period. (upper wave). As negative swing is increased conduction period is shortened

at the plate of V_2. The drop in voltage at the plate of V_1 is applied through the coupling circuit to the grid of V_2, driving it negative. Then the plate of V_1 is cut off by the suppressor, and the grid of V_2 rises exponentially to ground. When the plate of V_2 first goes positive, the grid will still be negative and conduction does not take place until the grid has risen to a certain voltage. The time required for this depends on how far negative it was driven originally. This depends on the plate current of V_1 which in turn depends on its grid bias. Thus a signal applied to the grid of V_1 con-



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use this sub-assembly service to solve your design and production problems.

You can speed up development and production of electronic devices of all types . . . meet those tough delivery dates. Just call on SEALTRON to design and build hermetically-sealed plug-in assemblies *especially* for your products! Produced with SEALTRON's expert engineering, biggest selection of stock seals, miniaturization "know-how," these assemblies:

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NEW TVOR

- increases plane let-down safety for any airfield
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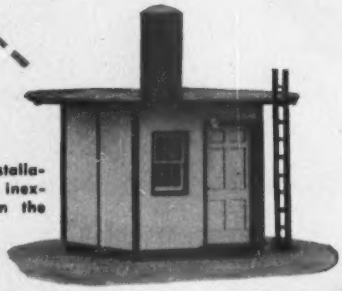
- permits marginal weather landings by private and executive aircraft.

AT LESS THAN *one fourth the cost of* VOR!



TVOR single unit installation needs only an inexpensive shelter on the field.

New terminal VHF omnidirectional radio range adds safe instrument approach facilities to any airport. CAA approved. Installs directly on the airfield. Includes field detector, antenna and installation test equipment. *And is available on 90 day delivery.*

TVOR radiates 50 watts of power, ample for most installations. It uses the same quality components and gets the same tests as CAA equipment. Installation operates almost entirely without attention. Any plane with standard VOR instrumentation can make precision approaches to a TVOR equipped field.

TVOR builds air traffic by extending service through marginal weather . . . increases airline passenger service by eliminating flights lost due to rain and fog . . . brings corporation aircraft to their home field in poor visibility.

Flight test TVOR with your own plane at the College Park Airfield. Convince yourself that your group cannot afford to be without low cost, high quality TVOR.

TVOR commercial transmitters are the same as those designed and built for the CAA.

TVOR changes fair-weather to all weather airline service.

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TVOR works with standard instrumentation. Private planes "home" on their own airfield.

MARYLAND ELECTRONIC MANUFACTURING CORPORATION
COLLEGE PARK MARYLAND

trols the current flowing through V_2. In the application for which this circuit was devised, the input to V_1 was 60 cycle from a temperature sensitive bridge, giving the circuit the advantage of phase sensitivity. It was sensitive only to an input in phase with the suppressor of V_1. However, d-c input works as well. Also, the role of suppressor and control grids can be interchanged.

The waveform photographs show the grid voltage (lower wave) and plate current (upper wave) of V_2, superimposed with an electronic switch. It demonstrates how the grid goes negative during the negative half cycle, and then rises until the tube fires and current flows. Negative grid swing and decrease in signal applied to V_1 is also shown with the period of plate conduction increased in the same manner, as indicated in operating theory.

Measurement of Harmonic Distortion With A Filter

SINCE IT IS CUSTOMARY to operate a magnetic recording system at the highest possible recording level that does not exceed the allowable distortion limits, it is important to have an accurate means of measuring the amount of distortion present in a system. Because recording level is also dependent on such variable factors as the properties of the magnetic medium, the bias current, the recording heads and the gain characteristics of the recording amplifier, the method should be simple enough for periodical checking of professional

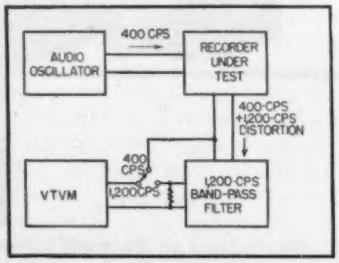
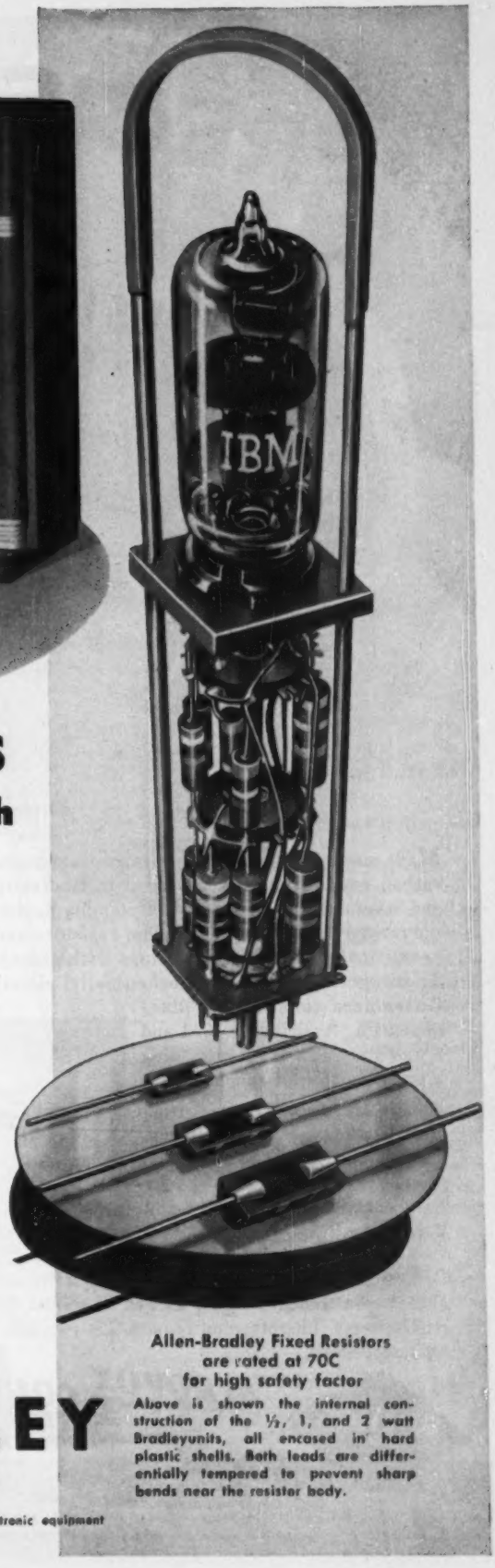


FIG. 1—Block diagram of distortion measuring system



OVER 10,000 BRADLEYUNITS
in this Electronic Calculating Punch

The IBM Electronic Calculating Punch, shown above, will punch 6,000 cards per hour, performing up to 60 operating steps for each card.

The master key is the IBM Electronic Tube Assembly which comprises an electron tube and several resistors and capacitors. There are more than 1,200 of these pluggable units in each punch. With 8 or 9 Bradleyunits per assembly there are over 10,000 Bradleyunits per punch.

Bradleyunits are ideal resistors for such critical service, because they are rated at 70C . . . not 40C . . . which assures stability and permanence.

Made in all R.T.M.A. values, Bradleyunits are available from 10 ohms to 22 megohms in ½ and 2 watt sizes, and from 2.7 ohms to 22 megohms in the one-watt size. They need no wax impregnation to pass salt water immersion tests.

Allen-Bradley Co.
110 W. Greenfield Ave., Milwaukee 4, Wis.

Allen-Bradley Fixed Resistors are rated at 70C for high safety factor

Above is shown the internal construction of the ½, 1, and 2 watt Bradleyunits, all encased in hard plastic shells. Both leads are differentially tempered to prevent sharp bends near the resistor body.

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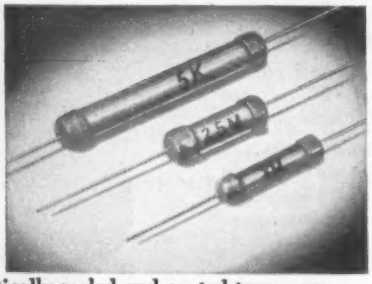
Made under Western Electric license agreement, these deposited-carbon resistors serve a real need in laboratory-grade instruments and assemblies. For superlative stability under the most adverse operating conditions, Carbofilm resistors are now available in hermetically-sealed metal casings with glass-to-metal end seals. Thoroughly protected — mechanically, electrically, climatically. Guaranteed tolerance of plus/minus 1%. Available in ½, 1 and 2 watt sizes. Just about everything a precision resistor should be!



Also in the coated (special resin film seal) type for accuracy, stability, economy. Guaranteed tolerance of plus/minus 1%. Excellent characteristics. ½, 1 and 2 watt sizes.

Carbofilm resistors, in both hermetically-sealed and coated types, are available in standard values as well as special values made to your requirements. Literature on request. Let us quote on your *precision resistance* needs.

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recording machines in the field.

A method of measuring distortion with a band-pass filter developed by the Minnesota Mining & Manufacturing Co., greatly reduces the time and equipment needed for this operation. In a magnetic tape overload the principal distortion results from the third harmonic component. By recording a pure sine wave and then separating the third harmonic and measuring it with a vacuum tube voltmeter, it is possible to determine the third harmonic distortion. This set up is shown in Fig. 1. The only equipment required is an audio oscillator with good waveshape, a vacuum tube voltmeter with a fairly wide

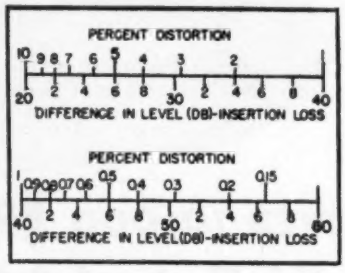

PERCENT DISTORTION
10 9 8 7 6 5 4 3 2
20 2 4 6 8 30 2 4 6 8 40
DIFFERENCE IN LEVEL (DB)-INSERTION LOSS
PERCENT DISTORTION
1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.15
40 2 4 6 8 50 2 4 6 8 60
DIFFERENCE IN LEVEL(DB)-INSERTION LOSS

FIG. 2—Alignment chart for converting decibels to percent distortion

range, and a band-pass filter. A 1,200-cps filter is ideal for this purpose since it is customary to measure distortion at 400 cps. However, a more common 100 or 5,000-cps filter can be used if the test frequency is adjusted to a suitable value. For highest accuracy, a filter having a rejection of at least 60 db at the fundamental, should be used.

Before testing a recording system it is necessary to calibrate it for the insertion loss of the filter. Since the input termination affects this value, the filter should be calibrated on the recorder under test. First, the output level is measured at 400 and 1,200 cps, with the filter disconnected, to determine if the level is the same at both frequencies. If it is not, the input must be readjusted during the test to compensate for the difference.

With the filter connected to the recorder, readings are taken at the filter input at 400 cps and at the filter output at 1,200 cps adjusting the input level as previously deter-

mined. The insertion loss of the filter is the difference between these two readings.

To make the actual distortion test, the 400-cps signal is fed into the recorder and the level reading taken at both the input and output of the filter. The true ratio between the signal and the third harmonic component is the difference between these two readings minus the insertion loss of the filter. This value can be converted to percent by use of the alignment chart in Fig. 2.

Once the insertion loss calibration has been made for a particular system, it is not necessary to repeat this step on subsequent tests. It is only necessary to connect the oscillator, filter and voltmeter and take two readings.

High Sensitivity Tone Discriminator

By Sidney Wald

Use of sharply tuned parallel-T R-C networks in place of L-C filters results in sensitive, compact, and inexpensive tone localizer that is useful in guidance or navigation equipment or as a low-frequency discriminator in f-m subcarrier systems.

In the usual arrangement for these purposes, band-pass L-C type filters are used in a subtractive rectifying circuit. The size and weight of these filters becomes large if reasonably high sensitivity is to be realized.

The circuit shown in Fig. 1 was designed as a tone-localizer for 90 or 150 cycle input. When equal amplitudes of 90 and 150 cps are present in the input, the meter reads zero center. When one signal amplitude is larger than the other, the d-c microammeter deflects to

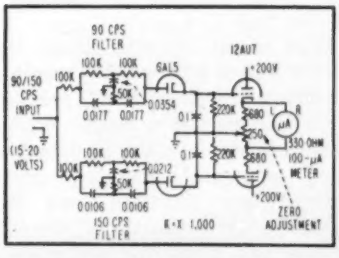
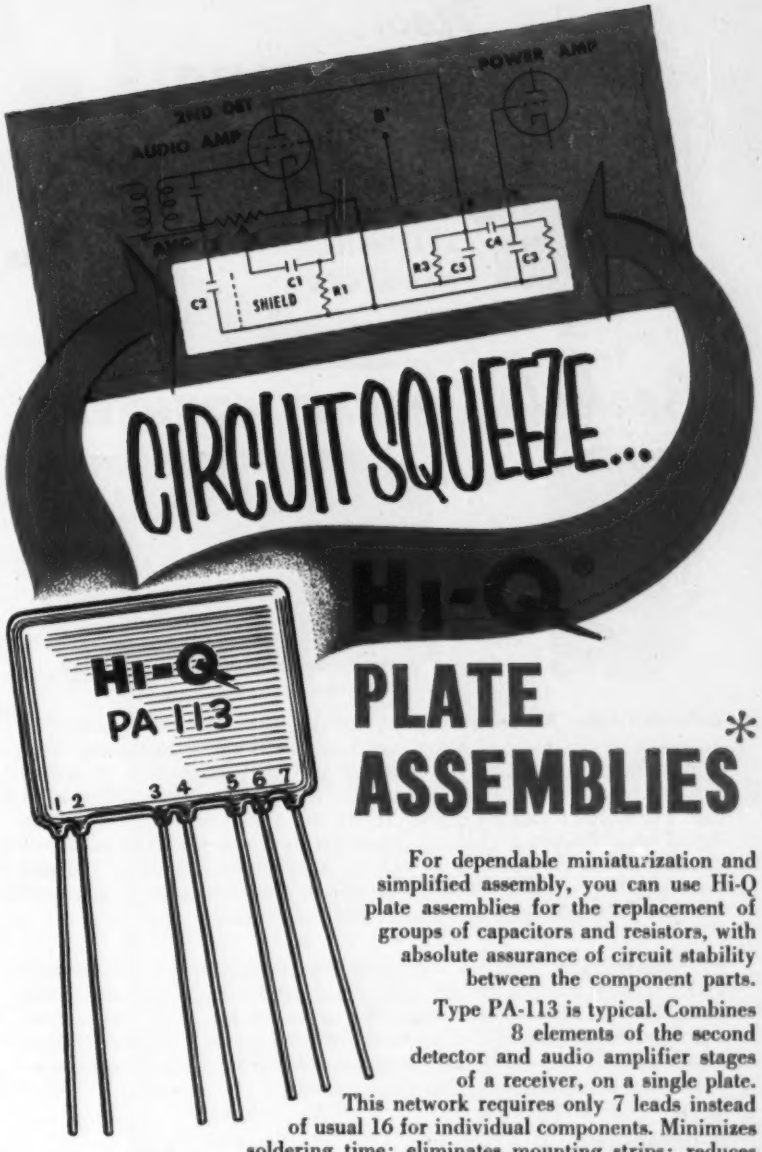


FIG. 1—Circuit diagram of the simplified tone indicator



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For dependable miniaturization and simplified assembly, you can use Hi-Q plate assemblies for the replacement of groups of capacitors and resistors, with absolute assurance of circuit stability between the component parts.

Type PA-113 is typical. Combines 8 elements of the second detector and audio amplifier stages of a receiver, on a single plate. This network requires only 7 leads instead of usual 16 for individual components. Minimizes soldering time; eliminates mounting strips; reduces stocking and handling problems.

Other Hi-Q plate assemblies provide vertical integrator, vertical integrator and coupler, audio plate grid coupler, pentode second detector and audio amplifier, pentode plate coupler and screen supply, etc.

*FUNCTION-FITTED TO YOUR NEEDS

Regardless what your "circuit squeeze" problems may be, Hi-Q specialists can provide the ideal solution in either standard or special types. Send us those problems!

FUNCTION FITTED

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SPECIFICATIONS	Model				
	422	423	424	425	426
MAX. COUNT CAPACITY	100	1000	10,000	100,000	1,000,000
INPUT SENSITIVITY (MIN.)	± 1 v. to ground, peak; at least 2 μ sec. wide				
OUTPUT	Choice of pos. pulse and relay closure, or pos. pulse. SPST relay closure approx. 1/30 sec; pulse output is + 125 v. with 3 μ sec. rise time and 15 μ sec. duration.				
PANEL DIMENSIONS	15⅜" x 8¾"		19" x 8¾"		
OVERALL DIMENSIONS	16⅛" x 10¼" x 13"		20¾" x 10½" x 15"		
POWER REQUIREMENTS	117 v. ± 10% @ 90w.		117 v. ± 10% @ 180 w.		
PRICE (F.O.B. FACTORY)	$375	$450	$595	$695	$795

M 3 *For complete information, please request Bulletin 102*

Berkeley Scientific

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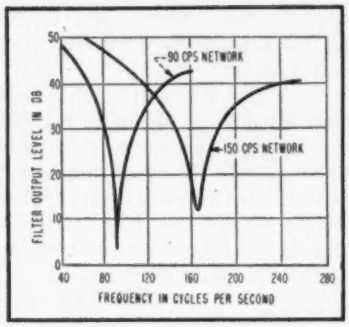

FIG. 2—Attenuation characteristics of the parallel-T filters

one side to indicate the relative magnitudes of the input frequencies. With the 100K-ohm input resistors in the circuit the output sensitivity is 50 μa deflection for 2 db difference between 90 and 150 cps signals into a 330-ohm microammeter. The input voltage is approximately 15 to 20 volts rms for this condition.

Figure 2 indicates the attenuation characteristics of the parallel-T filters.

Clutch Operates On Loudspeaker

A NEW CLUTCH that will find use in instruments and computers where fast response is required, uses the same moving-coil principle as an electrodynamic loudspeaker. Developed by the National Bureau of Standards, the clutch is actuated by the interaction of a magnetic field and current in a coil. The resulting force moves the coil causing the output disk to be pressed against the rotating input shaft. In an experimental model response time was less than a third of a millisecond.

The operating principle of the clutch makes it inherently capable of a faster response than is possible with most electric or magnetic friction clutches. In the loudspeaker type, the magnetic field is in existence before actuation, and the normally small induction of the coil is the only time factor involved. This coil inductance can be made

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Kel-F has high tensile strength on the order of 6000 psi at 77° F . . . excellent impact strength and abrasion resistance.

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Length — to specification
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Length — to 12"
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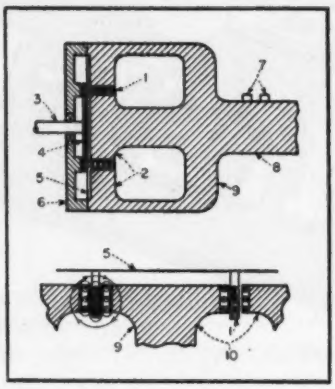

FIG. 1—Cross-sectional view of loudspeaker type clutch showing (1) actuating coil, (2) magnetic poles, (3) output shaft, (4) output disk, (5) flexible diaphragm, (6) backing disk, (7) slip rings for actuating current, (8) input shaft, (9) magnetic structure, (10) compensating coils. Lower diagram shows placement and action of compensating coils

negligible by the use of bucking or compensating coils, that have current flow in the opposite direction to that of the actuating coil. In the test model, the 1-kc inductance of the actuating coil was reduced from 2.4 mh to 0.15 mh.

In the experimental model, having an output torque of 10 ounce-inches, an electromagnet was used to provide the field. A permanent magnet could have been used, but the electromagnet allows shutting the field off to remove any magnetic particles that may have become attached to the pole pieces. The actuating assembly is mounted in the input member, and two sets of slip-rings carry the field and actuating currents to the rotating assembly. A thin flexible diaphragm attached to the actuating coil presses against the output disk when the coil is energized, holding the disk firmly against the backing disk.

An ordinary crystal phonograph pickup and an oscilloscope were used to test response time. The phonograph needle, resting in a small depression on the output shaft, gave an indication when motion started. Connecting the oscilloscope to the actuating switch and the phonograph pickup permitted observation of the time lapse between application of power and the

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Core Loss (TW)	0.95 x lbs.	3.75 x lbs.
Exciting Volt-Amps (AW)	1.85 x lbs. + 6.25A*	4.6 x lbs. + 16.6A*
* A = Gross Area of core face in Sq. In.		

All 2 mil cores are tested for pulse permeability by using a 2 microsecond pulse width at 400 P. P. S. and maximum net flux density of 10000 gauss. The minimum permeability will be 550.

All 1 mil cores are tested for pulse permeability by using a 0.50 microsecond pulse width at 1000 P. P. S. and maximum net flux density of 3000 gauss. The minimum permeability will be 350.

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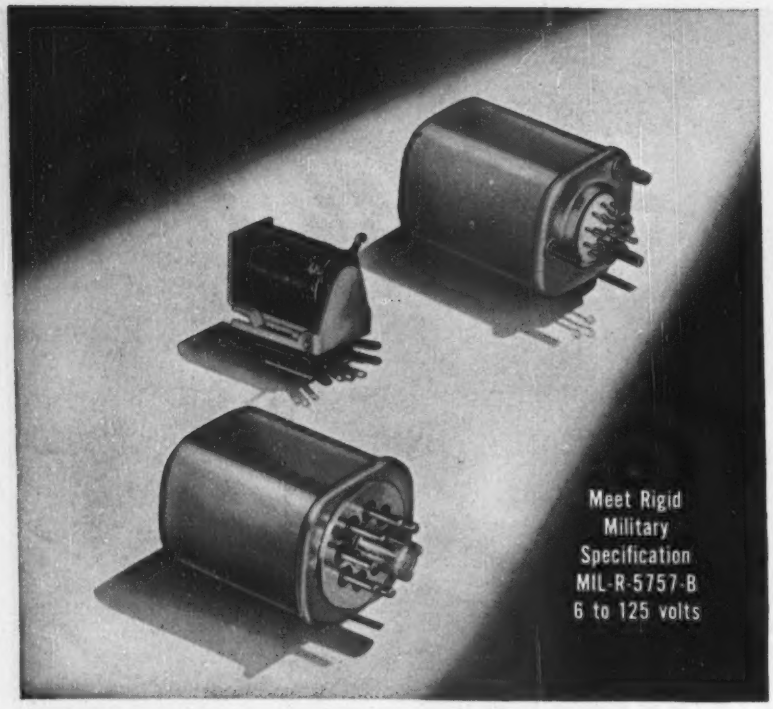

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AMERICAN ENCAUSTIC TILING COMPANY
MANUFACTURERS OF WAVEMETER TEST SETS, ELECTRONIC SMOKE DETECTORS, RELAYS
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start of motion in the output shaft.

Using 300 volts on both the field and actuating coils, the output shaft began to move within 200 microseconds and attained full speed in 300 microseconds. Using 100 volts on the field and 215 volts on the actuating coil, the time delays were 500 and 625 microseconds. The actuation voltages are required only momentarily and must be reduced promptly when the clutch reaches operating speed to avoid overheating and burnout.

When measuring response time, the effect of the compensating coils was also investigated. With the coil connections reversed so that the compensating coils aided rather than bucked the actuating coils, response time was increased to 900 microseconds. This indicates that the response time with the coils connected properly is limited by mechanical rather than electrical factors.

Deposited-Film G-M Counter Tubes

A NEW method for depositing a transparent, nonmetallic conducting film of constant thickness on the inside of a glass tube was announced recently by the Naval Research Laboratory, Washington, D. C. The new method has been used mainly, so far, for the production of halogen-quenched G-M counter tubes for laboratory research.

In the process, a nonmetallic film is deposited by condensation of a vapor on the inside of an electrically heated Pyrex glass envelope. A thin platinum-iridium wire is used for the anode, the tube is sealed off and mounted for a plug-in connection.

Various thicknesses of films have been deposited in this manner in areas up to 18 square inches. Although the films are actually colorless, they appear colored due to their light reflection-interference patterns.

The G-M tubes made by this process are nonsensitive to light, have an almost indefinite operating life, have uniform sensitivity response throughout their length and require no critical materials such as copper or stainless steel.

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Production Techniques

Edited by JOHN MARKUS

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Model of Television Plant Facilitates Rearrangement of Production Lines

A COMPLETE and accurate scale model showing locations of all partitions, shelves, benches, conveyors and offices in the 200,000-square-foot plant of Olympic Radio & Television was built for a total cost of only $100 and paid for itself in the first month of use. Light-weight steel angle iron was bolted together to represent the framework of the building. On one side the angle iron was partly cut out to permit sliding out the sheet of plywood used for each floor.

Floor plan blueprints, drawn to a scale of ¼ inch to the foot, are cemented directly onto the plywood and serve as guides for showing positions of permanent columns or partitions when rearranging a floor.

In the drawers of the table that supports the model are sets of wood blocks representing movable equipment and Lucite sheets representing partitions. Blocks representing shelves are painted yellow; blocks for benches are green; blocks for conveyor runs are red.

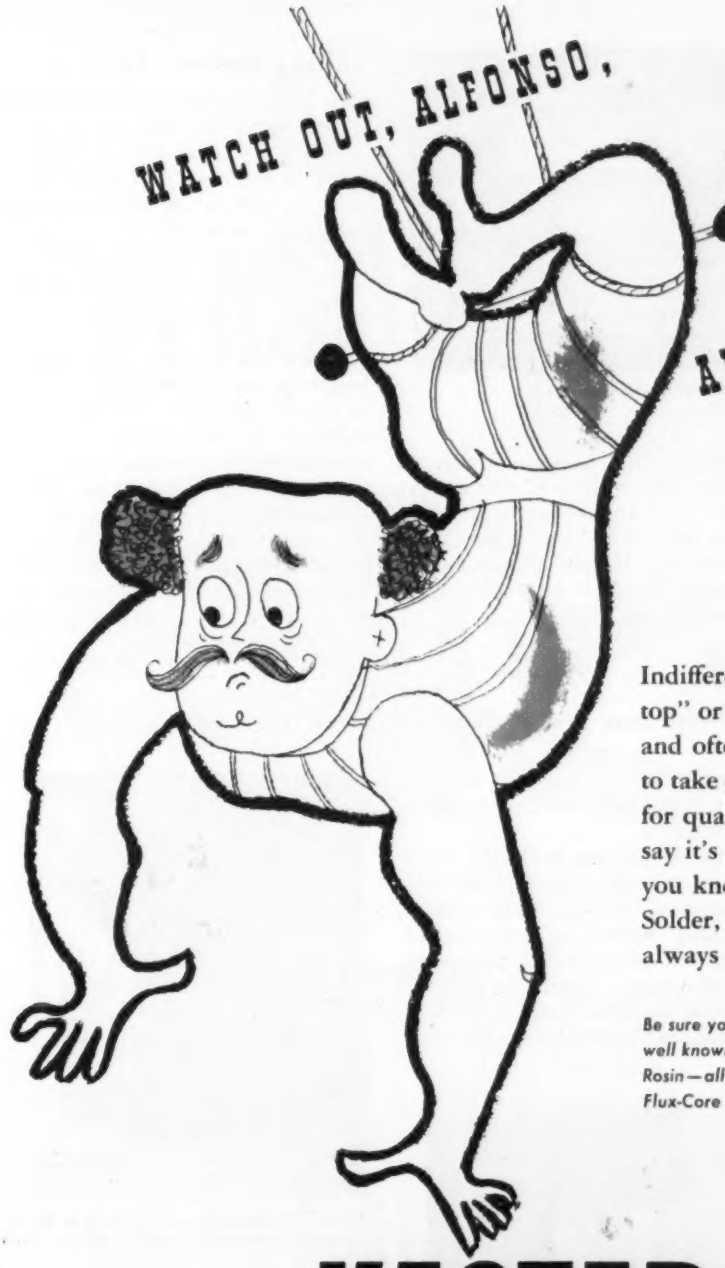
When the need for this model first arose, the price quoted for its construction by an outside firm specializing in such work was $3,000. Instead of accepting this bid, an alert young man in the plant was assigned to the job full time for a week to see what he could do. The results were entirely satisfactory.

B. Bordiga, director of manufacturing at Olympic, tries out an idea for rearranging benches on second floor of his plant simply by sliding out plywood floor of model and shifting accurately scaled wood blocks. When the best setup for a new production problem is found, a draftsman is called in to take measurements and notes from which new floor plans can be drawn

Turntable for Pass-Along Assembly Line

THE PROBLEM of getting a television chassis around the bend of a U-shaped pass-along assembly line was solved in Olympic's plant with a free-spinning five-foot-diameter disc of one-inch plywood. When a chassis reaches the last position on one side of the long bench, the operator lifts it onto the plywood turntable. Here there are permanently mounted cleats and supports to hold each chassis, spaced equidistant to give six positions on the turntable.

Depending on the needs of the line, one or more workers are stationed around the turntable to perform assembly or inspection operations while the sets are going around the bend. One of the workers advances the turntable each time another chassis comes to it. On the other side of the bench, the first operator takes each chassis in turn off the turntable and starts it on its ride down the rails on



Indifference—whether it's under the "big top" or on the production line—is inexcusable and often fatal. You simply can't afford to take chances with a hard won reputation for quality performance. That's why we say it's a pretty good rule to stick to a solder you know and trust . . . time-proved Kester Solder, constant in solder alloy and always a consistent flux formula.

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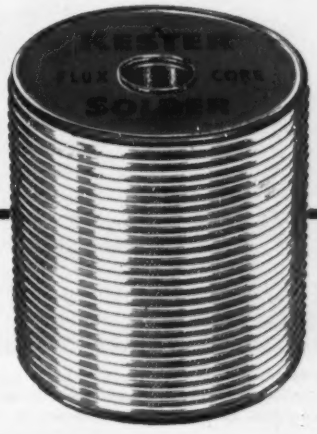

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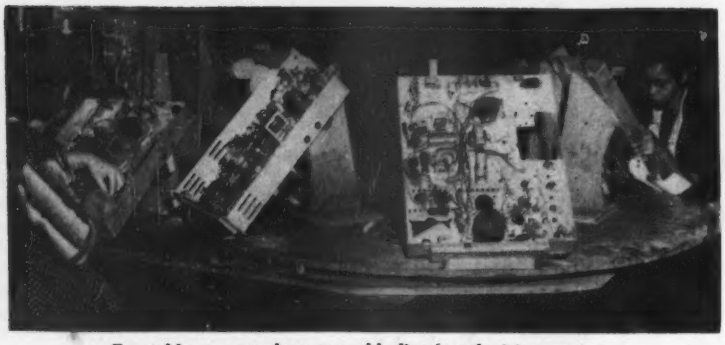


Turntable on pass-along assembly line for television receivers

that side of the bench.

No pallets are used on the benches; instead, the chassis slides on two wood rails, one low on the bench near the front edge and the other high enough to support the chassis at the desired working angle. A plywood strip is clamped to the bottom edge of the chassis with bolts and wingnuts to serve as a sled runner that rides in the lowest rail, thereby protecting the antenna terminal strip and other chassis parts.

Cutting Resistor Leads

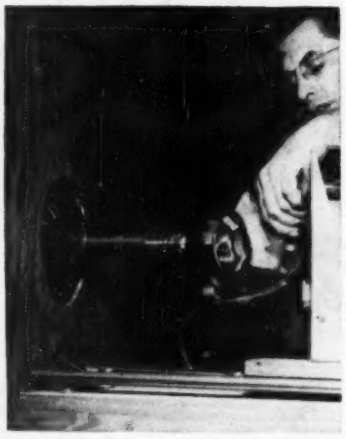
AN ORDINARY large hand-operated paper cutter is used at Olympic Radio & Television Inc. for cutting leads of resistors that come packaged in flat strips of corrugated cardboard. A group of a dozen or more resistors can thus be taken out of its shipping carton, placed on the cutting table and pushed against an adjustable stop. All leads on one side are cut to a desired shorter length in one downward movement of the cutting blade. The group of resistors is then turned over for cutting leads at the other ends.

In another manufacturers' plant, this same guillotine cutting action is used in an air-actuated two-blade automatic setup that cuts both leads simultaneously of each resistor in a flat-packaged group.

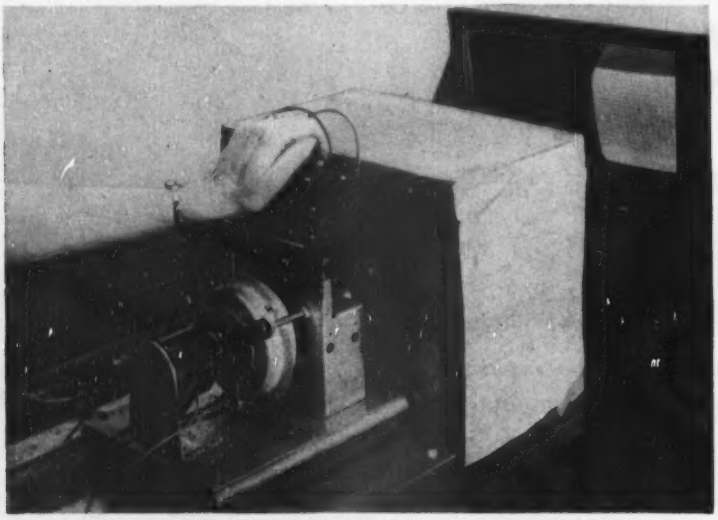
Defect-Indicating Diagrams for Deflection Yoke Test Set

IN THE FINAL performance of deflection yoke assemblies for Crosley television receivers, the picture-tube presentation associated with each type of yoke defect is shown on a chart attached to the side of the test set. When a defective yoke is encountered, the operator merely jots down the number of the observed diagram on the reject card. From this, troubleshooters can probe for the defect and clear it without need for further measurements.

The test set uses a 12-inch round picture tube of a type that does not require an ion trap. The tube is mounted rigidly in a protective metal box, with the neck projecting out the rear. Under the neck is a metal platform running on ball-bearing rails, on which are mounted the picture tube socket, focus coil and safety switch. This platform is pulled back on its rails so that a tested deflection yoke can be removed and the next one slipped onto the neck of the tube.



Placing 90-degree yoke over neck of 30-inch picture tube in DuMont test set



Crosley-developed test set for deflection yokes, with slant-line pattern for good yoke showing in mirror at upper right. Operator must press down cover of switch against spring action as shown in order to apply power for test

Test signals are obtained from a Raytheon-Belmont vertical and horizontal sync pulse generator, now manufactured by Supreme, Inc. A 630-kc oscillator generates dots, which appear on the screen as short slanting lines due to inten-

PLASTICON TYPE "M"*

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*PLASTICONS ...the original type "M" capacitors (Mylar** Dielectric)*

Miniature Type M Capacitors

Part Number	Voltage	Capacitance	D	L
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CM 152-4CA	400	.0015	.235	11/16
CM 222-4CA	400	.0022	.235	11/16
CM 332-4CA	400	.0033	.235	11/16
CM 472-4CA	400	.0047	.235	11/16
CM 682-4CA	400	.0068	.235	11/16
CM 103-4CA	400	.01	.235	11/16
CM 153-4CA	400	.015	.312	13/16
CM 223-4CA	400	.022	.312	13/16
CM 333-4CA	400	.033	.312	13/16
CM 473-4CA	400	.047	.400	13/16
CM 683-4CA	400	.068	.400	1-1/16
CM 104-4CA	400	0.1	.400	1-5/16
CM 154-4CA	400	0.15	.562	1-1/16
CM 224-4CA	400	0.22	.562	1-5/16
CM 334-4CA	400	0.33	.562	1-13/16
CM 474-4CA	400	0.47	.670	1-13/16
CM 684-4CA	400	0.68	.750	2-1/16
CM 105-4CA	400	1.0	.750	2-7/16

Also available in 100, 400, 600 and 1000 volt ranges

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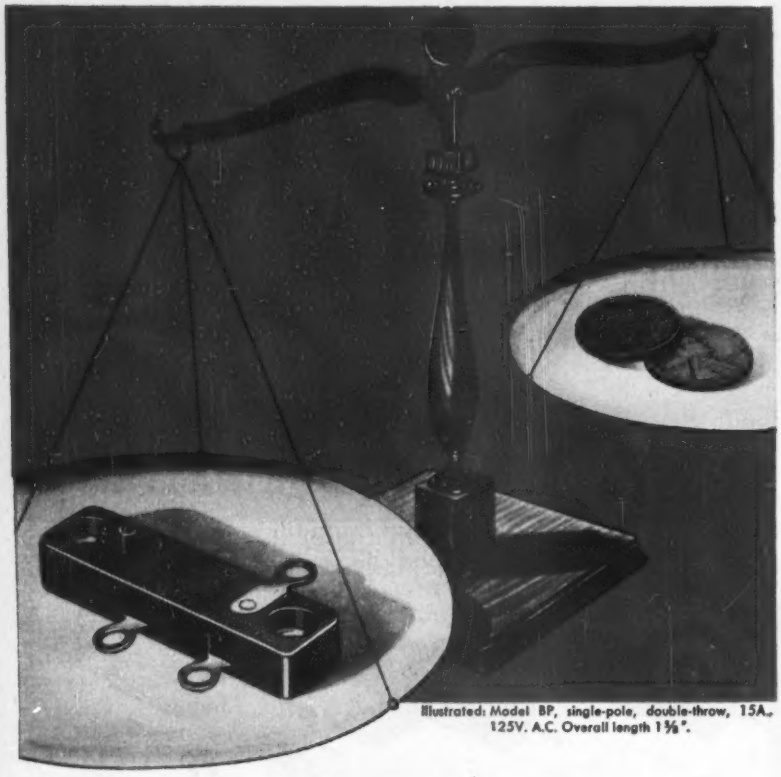


Illustrated: Model BP, single-pole, double-throw, 15A., 125V. A.C. Overall length 1 5/8".

The only miniature snap switch

where size and high rating come to terms with cost

Repeat: *where size and high rating come to terms with cost.* Consider this in terms of engineering that seeks to increase product efficiency while holding costs at a minimum. Then base your snap switch specifications on the following facts.

TYNISWITCH is a low cost, compact snap-action unit based on simplified construction principles. It permits high-load switching in a minimum amount of space. It eliminates costly, nonfunctional bulk in new or redesigned products. No other model or make — of comparable size and rating — can match its high-standard performance. Its action is flawlessly smooth and dependable. Moreover, it has been conclusively proven by approved laboratory tests that TYNISWITCH is completely reliable at high operating speeds . . . for over millions of cycles!

Investigate these and many other TYNISWITCH advantages today. New models can be developed economically to fit your speed and specifications—or you can select conventional circuit arrangements from a variety of standard units. Write for details. TYNISWITCH Division, The Sessions Clock Company, 104 East Main Street, Forestville, Connecticut.

Deflection yoke reject chart

tional misalignment of the test set. The direction in which the dots slant then indicates whether deflection yoke leads are correct or reversed.

A somewhat similar sliding platform is used for the same purpose in Final Test at the East Paterson, N. J. plant of Allen B. DuMont Labs. Inc. to test 90-degree yokes

There are hundreds of jobs open to engineers today!

but few opportunities like these

Westinghouse is in nuclear power to stay. We believe in the development of atomic energy as man's next great source of power. If you want to get in on a new era in industry, we want to talk to you.

Atomic power opportunities are waiting for electronic engineers with 4 to 10 years of this kind of experience...

ELECTRONIC COMPUTERS, employing pulse amplifying wide range linear amplifying and rate circuits.

NULL BALANCE DEVICES, employing both vacuum tube and magnetic amplifiers, SERVOMECHANISMS, PLANT CONTROL SYSTEMS.

LIAISON with customers, contractors, designers of component equipment.

SUPERVISION of drafting work.

REMEMBER! We are primarily interested in good *experienced* application and development engineers—lack of previous reactor development experience *is no handicap in this type of work.*

HOW TO APPLY! What Westinghouse wants to know is: Where and when you obtained your degree . . . how you did in school . . . where you have worked at your profession . . . what kind of work you have done.

In other words, right now we're more interested in your ability to fill current openings and to develop in the Westinghouse Atomic Power Division than we are in your vital statistics. Write your letter of application accordingly.

You will be in communication with men who are experienced in keeping secrets. All negotiations will be discreet, and your reply will be kept strictly confidential.

Address your application letter to: Manager, Industrial Relations Department, Westinghouse Electric Corporation, P. O. Box 1468, Pittsburgh 30, Pennsylvania.

What do you want?

MONEY? Good jobs are open here now—waiting for good men who want to make a permanent connection.

A PERMANENT JOB? Many of the engineers who joined Westinghouse 20 and 25 years ago are still with Westinghouse—and in key positions—and engineers who join us now will have the opportunity to make this work their lifetime careers. When many other industries may be going through slack times, atomic energy will still be in a stage of expansion.

SUBURBAN LIVING? It's here—within easy driving distance of your work. Within a few minutes of shopping centers . . . schools . . . metropolitan centers.

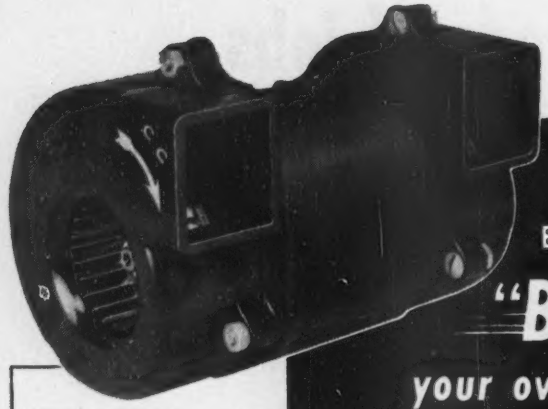
JOB EXTRAS? Westinghouse offers: Low cost life, sickness and accident insurance with hospital and surgical benefits. A *modern* pension plan. Westinghouse stock at favorable prices. Westinghouse appliances for your home at discount.

YOUR KIND OF ASSOCIATES? Every fourth person in the Division is an engineer or scientist. More than half the top Westinghouse executives are engineers.

FASCINATING WORK? What other branch of science offers such exciting challenges? So many opportunities for discovery? So many chances to benefit mankind? So many opportunities for original work?

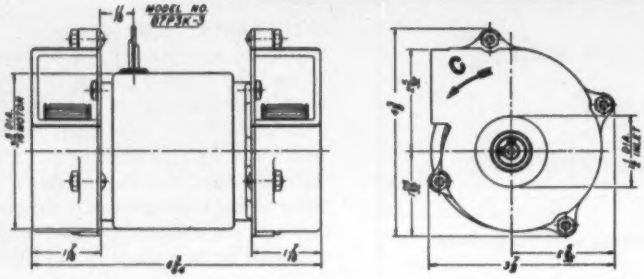
GROWTH OPPORTUNITIES? Never again in your lifetime will you be able to get into such a sure-to-expand industry so early in its development.

YOU CAN BE SURE.. IF IT'S Westinghouse



EAD ENGINEERING "BLOWS your overheating problems sky-high"...

Model B7P3K-3
Frame No. 70



Maximum cooling for airborne radar and hot-running electronic equipment is assured with this compact double-ended centrifugal blower. It meets government specifications for use at altitudes up to 50,000 feet. Another illustration of EAD's design ability!

SPECIFICATIONS

OPERATING FREQUENCY RANGE: 320 to 1000 cycles.

OPERATING TEMPERATURE RANGE: −55°c to +85°c.

AIR DELIVERY: 80 CFM @ 0" Static Pressure (Sea Level).

MOTOR: Self Cooling—wound and impregnated with Class H Insulation.

MOUNTING: Any Position.

OVERALL DIMENSIONS: 6-3/64" x 4-3/8" x 3-7/8".

Solving special problems is routine at EAD

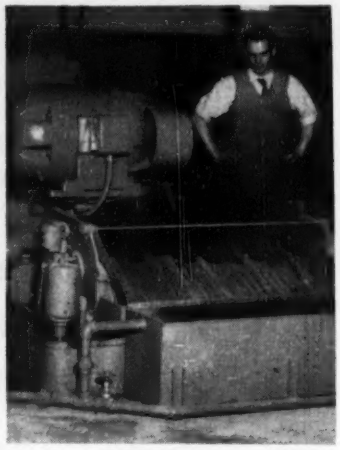
If your problem involves rotating electrical equipment, bring it to E A D. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

EASTERN AIR DEVICES, INC.

586 DEAN STREET, BROOKLYN 17, NEW YORK

for 30-inch picture tubes. Here the actual 30-inch tube is used in the test set. Connections to the yoke terminals are made with a plastic cable clamp.

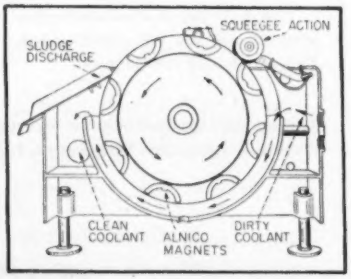
Magnetic Separator Recovers Alnico from Grinder



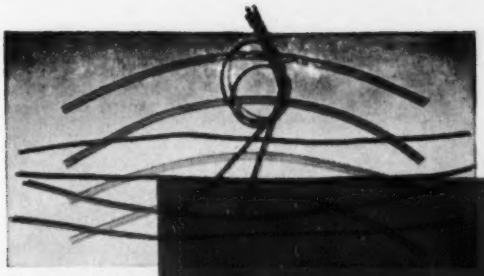
Alnico particles slide down metal incline to bin in foreground after being scraped off drum of magnetic separator, here installed on Besly No. 226 double-end grinder

VALUABLE particles of Alnico V are recovered and recast into magnets in the Peterboro, Ontario plant of General Electric Co., Ltd. by a magnetic automatic coolant separator made by Barnes Drill Co., Rockford, Ill. The separator is installed on a grinder that automatically trims Alnico castings to final size. The grinder is arranged to compensate for abrasive wear. Three pumps, each delivering 30 gallons per minute, bring the Alnico-bearing coolant water to the separator for recovery.

The separator itself uses Alnico magnets. These hold the desired



Cross-section of separator, showing how U-shaped Alnico magnets are mounted inside drum



MITCHELL-RAND
electrical
insulation headquarters
features...

hygrade and flexite

tubings and sleevings

to meet every particular insulation requirement

In the Mitchell-Rand line of HYGRADE and FLEXITE Tubings and Sleevings, there is a particular **grade** and **class** to meet the specific insulation requirement of temperature resistance, dielectric strength, abrasion resistance, flexibility and push-back. HYGRADE Tubings and Sleevings conform to the NEMA Standards VSI-1950 and to the Armed Services Specification MIL-1-3190.

The "Select-It" chart details the various grades and classes of HYGRADE Tubings and Sleevings... **grades** differ according to amount of insulating coating applied and **class** is a A.I.E.E. standardization to indicate the ability of varnished coated products to withstand heat and temperature rises: Class A: 105° C or 221° F, class B: 130° C or 277° F, class H: 200° C or 392° F. Class A is organic, treated with organic varnishes or coatings. Class B and H are fiberglas treated with organic varnishes or coatings.

Flexite Plastic Tubings... made from various grades and types of resins offer an extraordinary combination of qualities including high dielectric strength, flexibility, non-flammability, abrasion resistance, oil and chemical resistance, heat stability, and resistance to aging... are low priced to make them the most desirable tubings for many insulation problems.

Hygrade Tubings and Sleevings and Flexite in standard sizes of copper wire are available in black, red and yellow for Class A and B, and natural for Class H. Other colors are available on special order.

TYPE	GRADE	Minimum Dielectric *48/25/50	CLASS A	CLASS B	CLASS H	USE FOR APPLICATIONS REQUIRING:
HYGRADE IMPREGNATED	A-1	7000 v	X	X	—	Thin wall, smooth interior and exterior • no wicking, disintegration or swelling • thoroughly impregnated.
	B-1	4000 v	X	X	—	
	C-1	2500 v	X	X	—	
	C-2	1500 v	X	X	—	
	C-3	—	X	X	—	
HYGRADE SN	A-1	7000 v	X	X	—	Excellent electric characteristics, high insulation resistance under high humidity, good dielectric flexibility after flexing.
	B-1	4000 v	X	X	—	
HYGRADE VF	A-1	7000 v	—	X	—	Extreme flexibility, constant dielectric strength, abrasion resistance, non-burning, non-corrosive, non-stiffening.
	B-1	4000 v	—	X	—	
	C-1	2500 v	—	X	—	
	C-2	1500 v	—	X	—	
HYGRADE H	A-1	7000 v	—	—	X	Extreme temperature resistance. Flexible over temperature range —65° C to 260° C.
	B-1	4000 v	—	—	X	
	C-1	2500 v	—	—	X	
	C-2	1500 v	—	—	X	
	C-3	—	—	—	X	
THERMOFLEX "1200" THERMOFLEX Colored		Dielectric provided by space factor	—	—	X	Free of all organic matter ("1200" only). Fray-resistant to temperatures to 1200° F.

ELECTRICAL GRADES OF EXTRUDED PLASTIC TUBING

FLEXITE HT 105C	Approx. 800 v/mil	Underwriter approved for continuous operating temperatures to 105° C. Good resistance to heat deformation, excellent oil resistance.
FLEXITE STANDARD	Approx. 800 v/mil	Continuous operation to 80° C, bright colors, transparent.
FLEXITE E	Approx. 800 v/mil	Low temperature flexibility to —60° F, very flexible.
FLEXITE POLYTHENE	Approx. 1200 v/mil	High insulation resistance, chemically inert and insensitive to moisture. Flexible from —80° C to +85° C. Excellent for high frequency units.

MITCHELL-RAND SINCE 1889
Electrical Insulation Headquarters

Write to MITCHELL-RAND for free samples and descriptive data.

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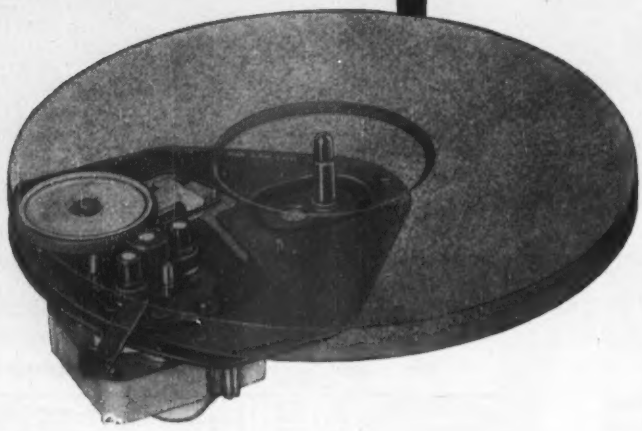
51 MURRAY STREET COrtlandt 7-9264 NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICTION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATING VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

fidelity



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with General Industries' Phonomotors

The fidelity reputation of your record players, phono-combinations, and portables begins at the phonomotor. Be sure it's a good reputation that stays good... protected by General Industries' *Smooth Power* Phonomotors.

Complete data and specifications on the entire line of *Smooth Power* Phonomotors will be sent promptly on your request.

50th ANNIVERSARY 1903-1953

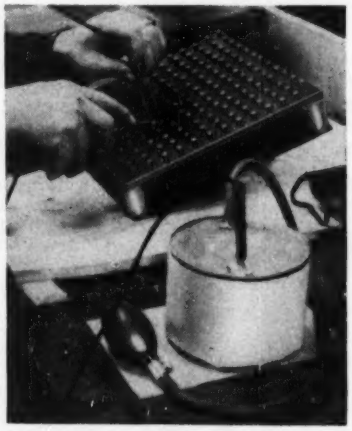
THE GENERAL INDUSTRIES CO.
DEPARTMENT MA • ELYRIA, OHIO

metal particles against a rotating drum while the waste water flows over the drum, until particles are removed by a scraper blade for salvage. The cleaning action of the separator permits immediate reuse of the coolant, with further saving in operating cost.

Water Cooling for Resistance Soldering Tool

A BATTERY CLIP serves as a simple and convenient valve for a small rubber hose used for cooling metal cable plugs after they have been heated for soldering. The rubber hose is taped to the resistance soldering tool used for this operation, with the battery clip conveniently positioned under the normal position for the operator's thumb. After making a joint, the operator squeezes the clip to spread its jaws and allow water to flow. The hose is so positioned that the stream hits the plug automatically, cooling it sufficiently so the operator can remove her hand from the soldered wire without waiting for the solder to cool.

Water pressure for the operation is obtained with an ingenious combination of an empty coffee can and a blood pressure valve with rubber bulb. The bulb and valve are used to produce air pressure in the can,



Improvised water cooling system using one-pound coffee can in foreground as reservoir. Water hose goes to resistance soldering tool in operator's right hand. Jig for supporting the plugs during soldering is made from heat-resisting material and has drilled holes to take 168 plugs at a time. Surplus water runs down angle-mounted jig onto rubber-sponge mat on bench

GERMANIUM DIODES

For use where size, long-life, and reliability under all weather conditions are important factors. General Electric is the largest supplier of germanium diodes in the country today.

VITAL CELLS IN THE "ELECTRONIC BRAIN"

Univac election prediction proves 99% accurate!

JUST two hours after the first polls had closed, Remington Rand's giant electronic computer predicted the election results *almost to the actual electoral vote!* UNIVAC accepted a mere three million vote count at 9:15 p.m. and juggled it with available "trends" over the past 25 years to uncork an answer since proven 99% correct!

16,000 G-E DIODES USED

What does this amazing mechanical mind consist of? Univac's makers in Philadelphia tell us that "90% of diodes used in the system are G-E, and without them, the equipment couldn't operate."

NEW CIRCUITS POSSIBLE

Recently announced G-E Diffused Junction Germanium Rectifiers open the door to even greater advancement in circuit design for this and similar equipment. G-E Junction Rectifiers feature extremely low forward resistance, high inverse voltage, hermetic seal, and miniature size. Their application may result in units that will do more work . . . . . more efficiently . . . . . less expensively.

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

DIFFUSED JUNCTION GERMANIUM RECTIFIERS

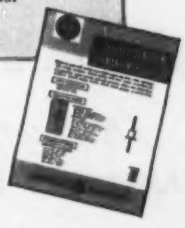
Developed for radar and military communications. May be applied to computers, magnetic amplifiers, TV receiver power supplies, telephone switchboards, and many other electronic fields.

NEWS FROM OUR ADVANCED DEVELOPMENT LABORATORIES

G-E scientists have tested specially made germanium junction rectifiers and transistors at 140°C. Results indicate new products may be usable at higher temperatures.

SEND FOR THESE FREE BULLETINS

. . . on G-E Diodes and Junction Rectifiers. General Electric Co., Section 423, Electronics Park, Syracuse, New York.



GENERAL ELECTRIC

from
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point
of view

you'll do better
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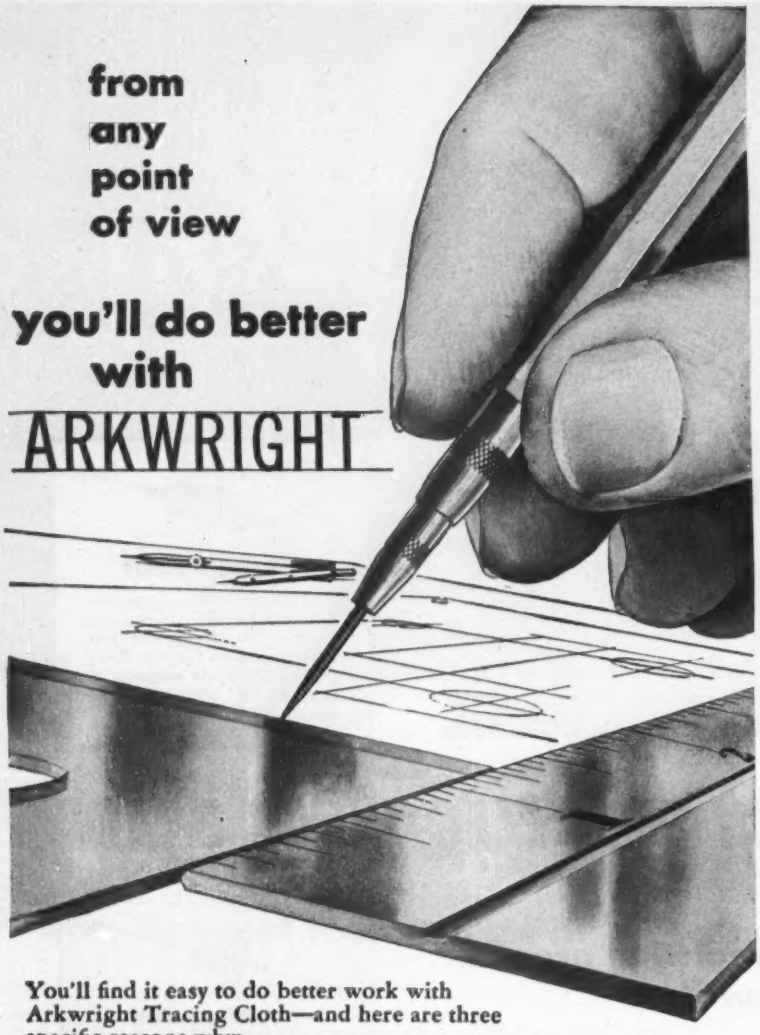
ARKWRIGHT



You'll find it easy to do better work with Arkwright Tracing Cloth—and here are three specific reasons why:

1 You can re-ink razor-sharp lines over any erasure without "feathering" or "blobbing".

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They're important reasons for putting *your* best work on Arkwright Tracing Cloth. Like a sample? Write Arkwright Finishing Co., Industrial Trust Bldg., Providence, R. I.

ARKWRIGHT
Tracing Cloths
AMERICA'S STANDARD FOR OVER 30 YEARS

so as to force out water when the battery-clip valve on the soldering tool is open.

Tubulations are soldered to the cover for the air and water hose lines. The cover is sweat-soldered to the can. Filling with water, required only about three times a day during continuous production, is done through a threaded plug in the bottom of the can.

When water pressure gets so low that the stream no longer hits the hot plug, the operator merely reaches over and gives the rubber bulb a few squeezes to build up pressure again. The technique was developed in the East Newark, N. J. plant of Utility Electronics.

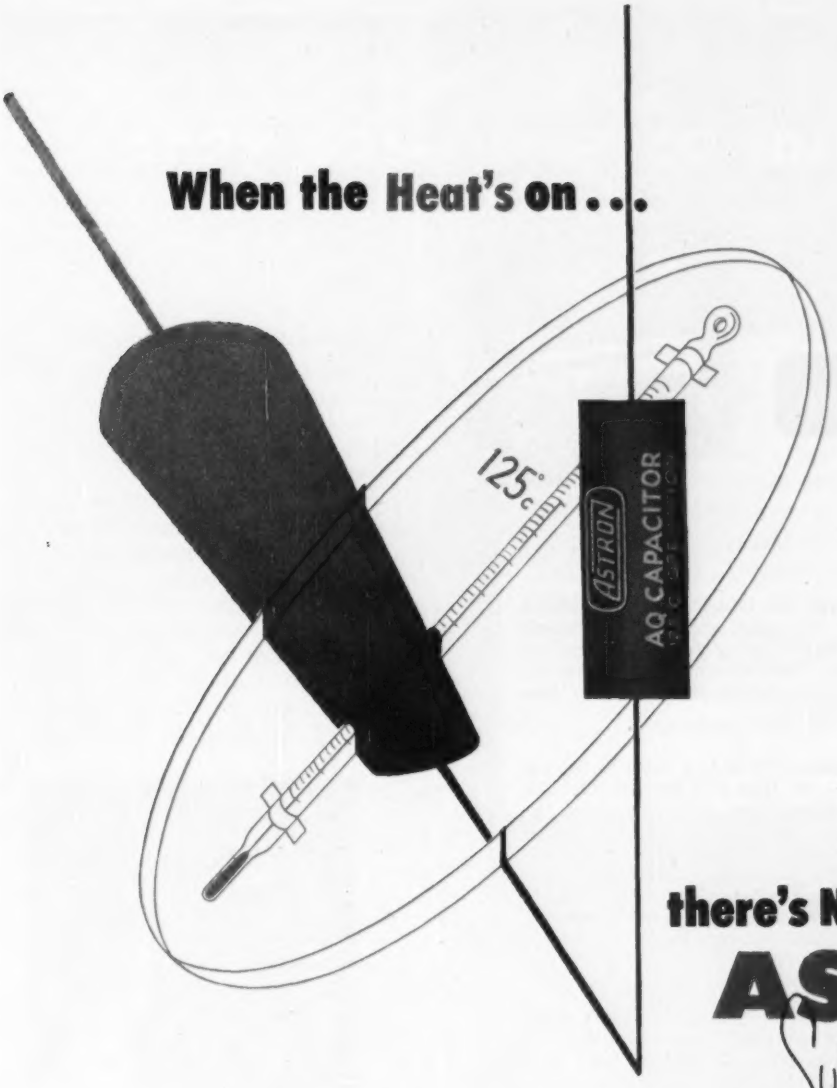
Reject-Identifying Board

AS A GUIDE for sorting defective television receiver coils and transformers for return to vendors, a sample board containing one of each type and make of coil is maintained in Olympic's Long Island City plant. The products of twelve different vendors are represented. Coils are grouped by function and identified by number.

As an example, ten different units differing in only minor details are wired to the board over the heading

Using coil sample board to identify a defective unit. Vendors are identified on board by code letters, generally the first letter in the company name. Loops of wire pass through holes in board to hold each sample in position

When the Heat's on . . .



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ASTRON

TYPE AQ

Subminiature

PAPER CAPACITORS

Astron Type AQ Subminiature Paper Capacitors are designed for dependable operation at temperatures up to +125°C. *without derating*—thanks to Astron's newly developed high temperature impregnant, X-250*. They also provide exceptional capacitance stability over the wide range of −65°C. to +125°C.

High insulation resistance, low power factor, unusually low resonance loss, and high test voltage are achieved in an amazingly compact and rugged unit meeting all Armed Forces requirements. All AQ's are non-inductively wound in an extended foil construction. Glass-to-metal seal terminals assure positive hermetic sealing. And Astron AQ's are supplied in a variety of construction styles to meet your specific needs.

Write for engineering bulletin, containing test specifications and performance characteristics of Astron AQ Subminiatures, *today*.

Astron manufactures a complete line of dry electrolytic capacitors, metallized paper capacitors, plastic molded capacitors, subminiature paper capacitors and standard and subminiature RF interference filters for every radio, television and electronic use.

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ASTRON

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Export Division: Rocke International Corp., 13 E. 40th St., N.Y.C.
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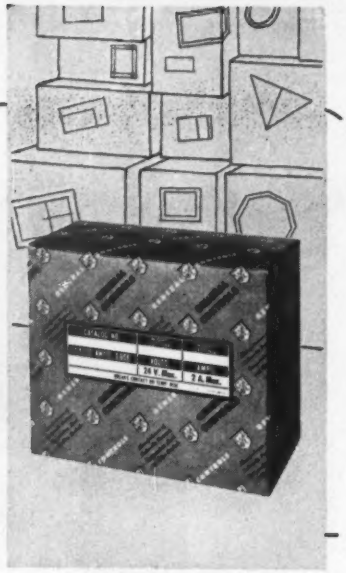
*Trade Mark

Want more information? Use post card on last page.

You can eliminate topheavy package inventories with **Avery** Kum-Kleen *labels!*



a common problem... General Controls Co. of Glendale, California manufactures automatic controls for widely diversified applications. Warehousing formerly required segregation of more than 100 different boxes. Product changes, from time to time, would make certain preprinted box inventories obsolete.

solved with Kum-Kleen labels... Now box inventories are maintained by size alone—IN HALF THE ORIGINAL SPACE! A self-adhesive Kum-Kleen label identifies the contents of each box *as it is used.*
According to General Controls, "The unique characteristics of Kum-Kleen labels made this new packaging program possible, and they are saving us many thousands of dollars yearly." Their many Avery electric label dispensers "are proving themselves daily to be a most worthwhile investment as a time and labor saver."

how Kum-Kleen labels work... They're *pressure sensitive*—LAID ON *fast* with a finger-touch—no moistening, no mess! They stay neat and attractive—won't dry out, pop, curl or peel. Patented Avery dispensers—manual or electric—feed die-cut, Kum-Kleen labels off roller tape for quick, clean labeling.

Where can YOU use these labels in YOUR business?

For case histories, samples and prices, please mail the coupon below.

Kum-Kleen *pressure-sensitive labels*

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☐ *Please send case histories, free samples.*

☐ *Have Avery label man call.*

Our business is _____

name _____

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company _____

address _____

"Pix I-F Coil"; here it is often necessary to compare an unknown coil carefully with each one on the board in turn to determine its manufacturer. This detailed comparison is only required a few times a day, as rejected coils usually come through in batches all from one vendor.

Spring Scale Checks Slip

INSPECTION of cavities for RCA pencil triodes involves checking the force required to move the plunger in the cavity. To check this in the Harrison, N. J. tube plant of the manufacturer, an ordinary spring scale is mounted upside down on a rack and gear arrangement operated by a hand wheel.

The operator places a finished cavity on the anvil, then turns the hand wheel to lower a cylinder which is mounted on a rod that goes inside the scale to its weighing point. With the left hand re-

Upside-down scale operated by rack and gear measures downward testing pressure being applied to plunger in pencil triode cavity. New printed numbers have been placed on scale so operator does not have to read upside-down values

LAPP GAS-FILLED CONDENSERS

For duty at high voltage and high current, Lapp Gas-filled Condensers offer the advantages of extreme compactness . . . low loss . . . high safety factors . . . puncture-proof design . . . constant capacitance under temperature variation . . . grounded tuning shaft . . . complete reliability—electrically and mechanically. Models for capacitances up to 60,000 mmf; current ratings to 525 amps at 1 mc; voltages to 100 kv peak.

Write for description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.

Lapp

maining on the cavity in order to feel for any slip, the operator turns the wheel to apply pressure while watching the pointer on the scale. Loose plungers are set aside for repair or replacement.

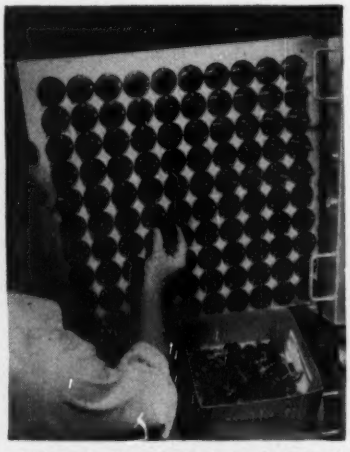
Tube Aging and Testing Techniques

PRODUCTION of miniature and subminiature tubes is expedited through use of a large variety of test sets and aging racks in Sylvania's Emporium plant. Most of these are applied 100 percent to the entire production to meet the requirements for premium tubes.

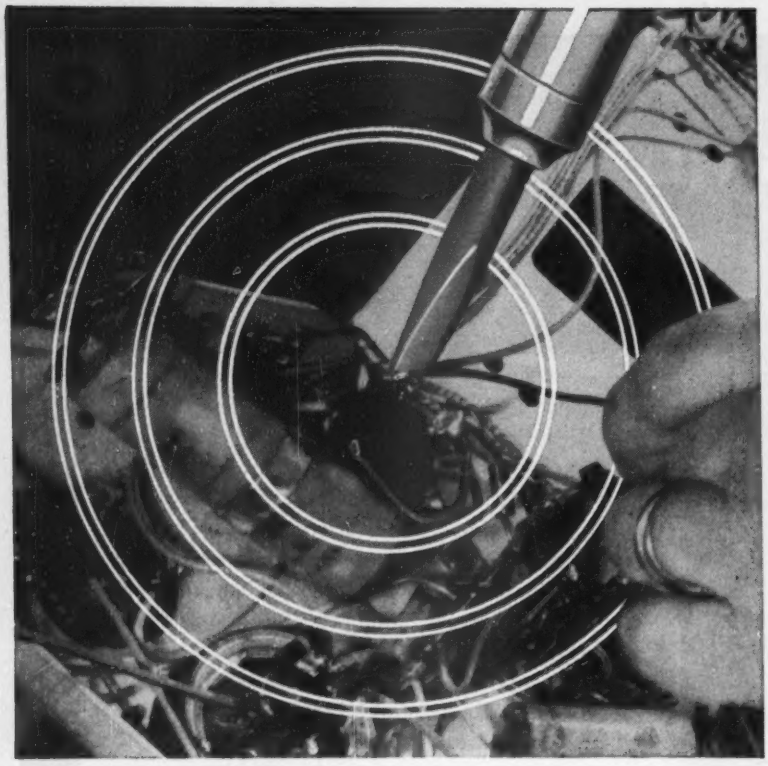
Tubes are aged on vertically mounted sliding drawers each having 100 sockets. Plugs at the rear of each drawer mate automatically with jacks at the rear of the rack when the drawer is pushed in, to apply the required voltages for aging. Miniature tubes plug directly into the sockets. Subminiatures are mounted in octal adapters that in turn plug into drawers having octal sockets.

The pull-out drawers are supported by roller suspensions at the top. Power supplies are below the drawers, in sections having a similar pull-out construction.

At the front of each drawer are two lamps with jewels. One indicates application of normal d-c plate voltage, and the other indicates a



Pull-out drawers for aging tubes. Each drawer has 100 sockets. Operator is here loading one with type 6095's, which are the ruggedized equivalents of 6AQ5 pentodes



You can't beat a soldered connection

for electrical conductivity and permanence!

SOLDERED connections eliminate loss of current, fire hazard, radio interference and excess heat which result from loose, corroded, arcing NON-SOLDERED connections.

For over 50 years experts have specified American Beauty Electric Soldering Irons. They know American Beauty Irons are built to LAST LONGER, OPERATE DEPENDABLY and BE SERVICED QUICKLY.

Build better with solder . . .
Solder better with
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At last! A tubing that's TAILOR-MADE FOR TV ANTENNAE

REYNOLDS ALUMINUM ANTENNA TUBING

HIGH STRENGTH ALUMINUM ALLOY CORE FOR *INCREASED DURABILITY*

HIGH PURITY ALUMINUM *RESISTS CORROSION... GIVES BRIGHTER FINISH*

Diligent research by the industry's electronics engineers have brought forth wonderful improvements in today's television receivers . . . and antenna designs that insure better performance. Now, Reynolds—pioneer producer of antenna tubing—offers a vastly superior *aluminum antenna tubing* to help *you* produce a superior antenna! The new Reynolds Aluminum Antenna Tubing is precision roll-formed . . . tailor-made for TV antenna manufacturers. It is extra-sturdy, lightweight, and its gleaming, corrosion-resistant finish *invites* sales.

Reynolds Antenna Tubing 31—a maximum strength tubing; and Reynolds Antenna Tubing 41—designed with ample strength for most demands. Available in either butt seam or lock seam tubing, Reynolds Aluminum Antenna Tubing is offered in a complete range of sizes and in lengths to meet your specifications. For additional information and sample sections, call your nearest Reynolds Sales Office listed under "Aluminum" in the classified telephone directory.

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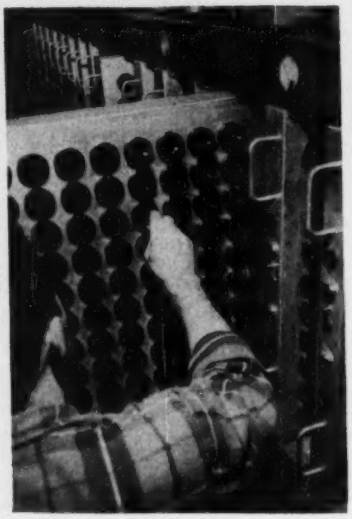
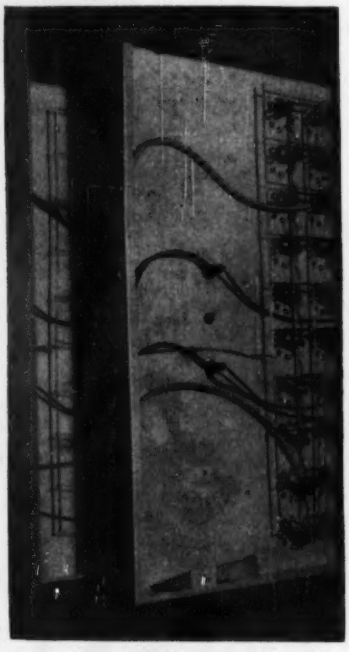


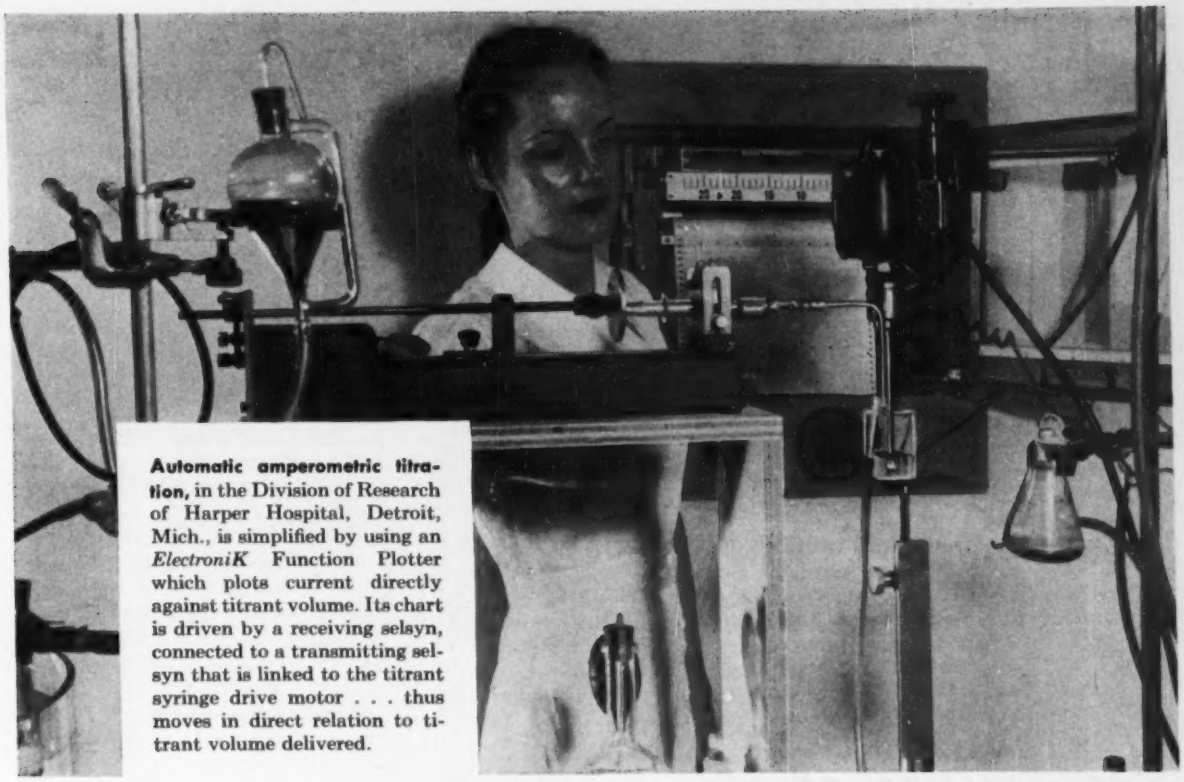
Drawer for octal sockets, used with octal adapters for subminiature tubes

heater-cathode short in one of the tubes. In the event of a short, which is rare, the tubes must be pulled out one by one while power is being applied, until the shorted tube is removed. The bad tube is indicated by darkening of the short-indicating lamp.

High-temperature life runs of subminiature tubes are carried out

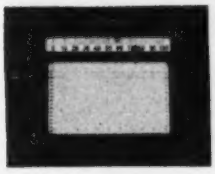


Rear view of slide-out aging drawer, showing jacks that make connections to mating jacks at rear of rack. Supporting rollers are at top of drawer and locking latch is at bottom



Automatic amperometric titration, in the Division of Research of Harper Hospital, Detroit, Mich., is simplified by using an *ElectroniK* Function Plotter which plots current directly against titrant volume. Its chart is driven by a receiving selsyn, connected to a transmitting selsyn that is linked to the titrant syringe drive motor . . . thus moves in direct relation to titrant volume delivered.

Speed your data recording with these *ElectroniK* instruments



For recording y = f (x)—the Function Plotter. One of the best time-savers for any laboratory, this instrument automatically records a continuous curve such as stress vs. strain, speed vs. torque, temperature vs. pressure. It eliminates hours of hand logging and point-by-point plotting. It has two independent measuring systems; one moves the pen, the other moves the chart. Optional selsyn drive for the chart can also be supplied. Either can measure any variable that can be converted to a d-c signal. The chart moves 11 inches, at only 4 seconds for full travel. Pen movement is 11 inches; pen traverse time 2 seconds.

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● **REFERENCE DATA:** Write for Data Sheet No. 10.0-5 on the Function Plotter . . . and Data Sheet No. 10.0-6 on the Duplex Recorder.

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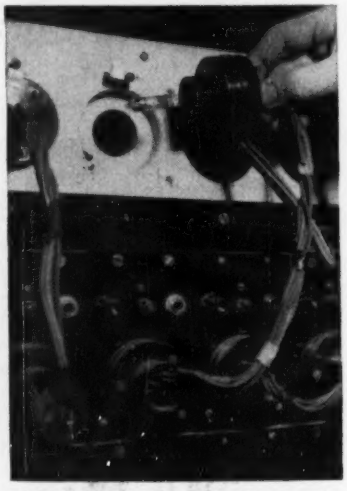
Rack for holding five subminiature tubes at a time inside high-temperature oven

with small panels holding five tubes each and with individual single-tube panels that mount over holes in the ceramic lining of an oven. The tubes project inside where they are subjected to a temperature of 175 F for accelerated life runs of 500 hours, 1,000 hours and even up to 5,000 hours in some cases. Normal operating voltages are applied. All important characteristics of each tube are measured every 500 hours or less.

High-temperature tests are conducted on a sampling basis, to show how tubes hold up in equipment that runs at high temperatures. This is important in the special applications for which a large number of these subminia-



Method of supporting subminiature tube in life test oven. Swinging metal tab above hole in oven locks socket in position. Neon lamp on panel below indicates shorts, and jack permits monitoring of tube current at 500-hour intervals during the run

Revlon's Treasurer and General Manager, Joseph Revson, with "Fire and Ice" girl Dorian Leigh

He kept 7,235 dates with this girl!

Five months ago she was just an idea. Today, as the temptress who sells Revlon's new "Fire and Ice" Lipstick and Nail Enamel, she's America's most talked-about glamour girl!

"She created the greatest shipping problem we ever had," says Joseph Revson. "7,235 stores wanted 'Fire and Ice' merchandise and displays – to be delivered *before* the promotion date of November 1.

"There was only one way to keep all those dates! And as heavy re-orders flooded in, we continued to fill them via Air Express. Volume is now the heaviest in our history! In maintaining that momentum—and keeping the good-will of the stores—Air Express service has been invaluable.

"We don't overlook costs, either. Air Express rates are the lowest in the field on practically every shipment we make. With a volume like ours, those savings add up to a very substantial figure!"

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1 mv—100 v	Voltage Range
10 cps—150 kc	Frequency Range
2% ENTIRE RANGE	Accuracy
½ meg. shunted by 30 μμf	Input Impedance

SUB-AUDIO TO 150 KC [Battery Operated] **Model 302B**

100 μv—100 v	Voltage Range
2 cps—150 kc	Frequency Range
3% 5 cps—100 kc 5% 2 cps—5 cps 100 kc—150 kc	Accuracy
2 meg. shunted by 15 μμf*	Input Impedance

AUDIO TO 2 MC — **Model 310A**

100 μv—100 v	Voltage Range
10 cps—2 mc	Frequency Range
3% to 1 mc 5% 1 mc—2 mc	Accuracy
2 meg. shunted by 15 μμf*	Input Impedance

AUDIO TO 6 MC — **Model 314**

1 mv—1000 v (100 uv—1 mv without probe)	Voltage Range
15 cps—6 mc	Frequency Range
3% to 3 mc 5% 3 mc—6 mc	Accuracy
11 meg. shunted by 6 μμf (1 meg. shunted by 25 μμf without probe)	Input Impedance

PEAK-TO-PEAK — **Model 305**

1 mv—1000 v pk-to-pk	Voltage Range
10 cps—100 kc (Sine Wave)	Frequency Range
3 μsec—250 μsec	Pulse Width
20 pulses per sec.	Min. Rep. Rate
5% for pulses	Accuracy
2 meg. shunted by 15 μμf*	Input Impedance

*Shunt capacitance is 8 μμf on all ranges except two most sensitive ranges.

Write for complete catalog of all Ballantine Electronic Instruments

BALLANTINE LABORATORIES, INC.

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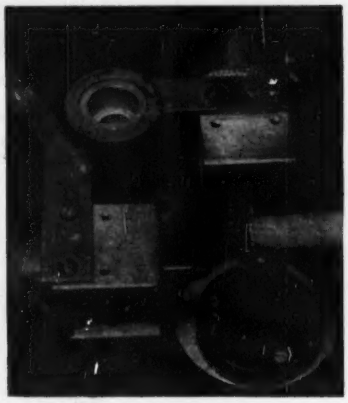
Aging and preheating conveyor used to transport tubes from Sealex machine (off picture at right) to operator at first test position

ture tubes are intended. Temperature in the oven is automatically controlled.

Initial aging of all tubes is accomplished automatically by the moving conveyor that transfers tubes from the automatic tube machine to the first test position. This short-period aging also serves to preheat the tubes, thereby speeding up the electrical test.

Each slat on the conveyor contains nine tube sockets, to which the required voltages are fed through a



Closeup view of socket on test set, showing solenoids that drive plungers against tube in sequence when pressure is applied to socket. A snap-action switch, located under the socket, initiates the tapping action

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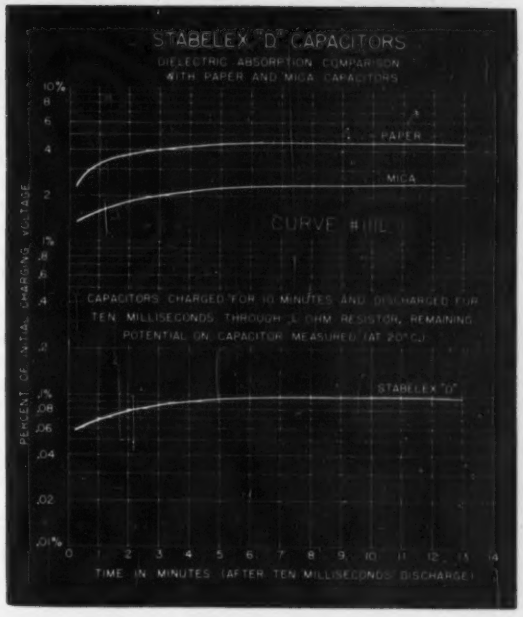
STABELEX "D" CAPACITORS
DIELECTRIC ABSORPTION COMPARISON WITH PAPER AND MICA CAPACITORS
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MICA
CURVE #1111
CAPACITORS CHARGED FOR 10 MINUTES AND DISCHARGED FOR TEN MILLISECONDS THROUGH 5 OHM RESISTOR, REMAINING POTENTIAL ON CAPACITOR MEASURED AT 20°C.
STABELEX "D"
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Curve #1111 illustrates the low dielectric absorption of Stabelex "D" and also makes a comparison with mica and paper capacitors. The absorption of mica and paper capacitors may be considerably higher, depending on the impregnating materials and design. The dielectric absorption of Stabelex "D" is never more than 1/25th that of the best commercially available Mica capacitors or 1/35th that of Paper capacitors.

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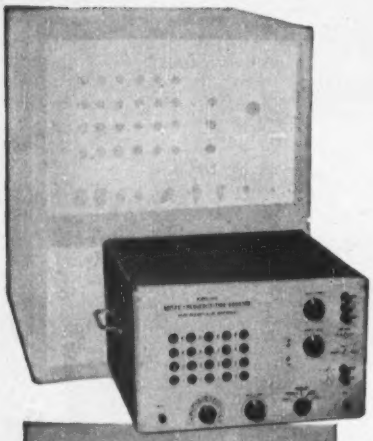

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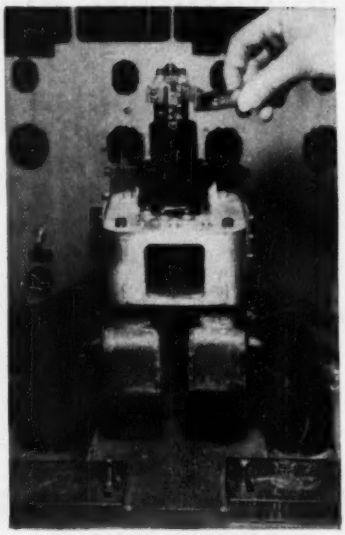
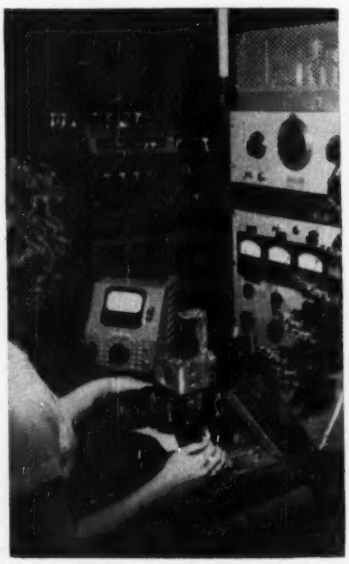


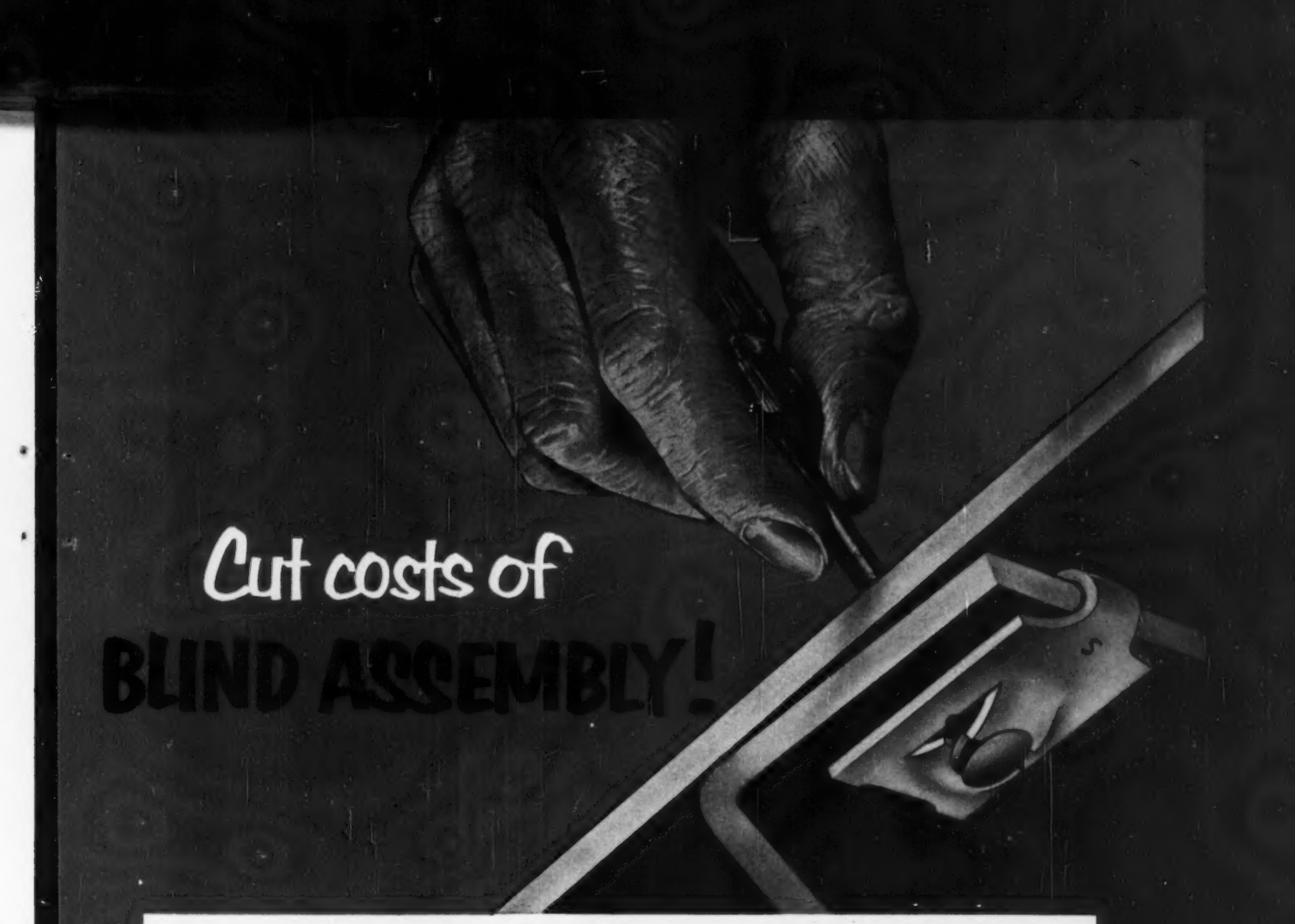
Method of locking subminiature tube in position, and construction details of exciter

system of brushes and wiping contacts. As tubes are taken out of the Sealex machine, they are inserted in sockets on the conveyor for a ride over the top. The tubes come down alongside the operator at the test position, within easy reach for transfer to the socket in front of her.

Insertion of a tube in the test socket automatically energizes two solenoids in sequence to drive fiber rods sharply against the tube from directions 90 degrees apart. This



Vibration test set using magnetron magnets for 100-percent production testing of subminiature tubes



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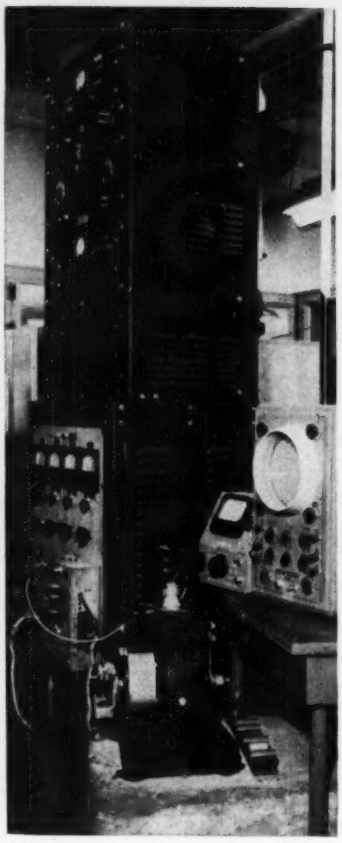

Laboratory-type vibration test setup used for sampling inspection of tubes. Exciter is mounted on concrete block to minimize extraneous vibrations

test reveals loose elements by noise heard from the loudspeaker behind the sloping panel of the test set. Pushbuttons are then operated to make remaining tests in quick succession on tubes that pass the vibration test.

Conveyor speed is governed by the rate at which the operator can remove tubes for tests. If any tubes are left in long enough to reach a wire stretched across the conveyor near the floor, they trigger a snap-action switch that stops the conveyor. Cord sets equipped with Jones plugs are used to change conveyor aging voltages whenever a different type of tube is placed in production.

Premium subminiature tubes are given a 100-percent test for ability to withstand 15g vibration at 40 cycles. The exact magnitude of vibration is calculated from the measured displacement of the tube

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RCA WO-88A
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Other quality features common to both designs include . . . push-pull direct-coupled amplifiers . . . extra fast retrace . . . shielded CRT gun . . . plus and minus sync . . . line-frequency sweep with phasing . . . and a set of matched probes and cables including a high impedance probe having an input resistance of 10 megohms and an input capacitance of less than 10 uuf!

Before selecting a 'scope for your special needs, be sure to get the full details on the WO-88A and WO-56A from your *RCA Test Equipment Distributor* . . . or write RCA, Commercial Engineering, Section 42BX, Harrison, New Jersey.

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Now, Klein quality pliers are available in new compact patterns for precision wiring and cutting in confined space. Note, too, the replaceable leaf spring that keeps the plier in open position, ready for work. All are hammer forged from high-grade tool steel, individually fitted, tempered, adjusted and tested—made by plier specialists with a reputation for quality "since 1857."

LONG NOSE PLIER
307-5-½L—Extremely slim pattern ideal for the really tight spots. Jaws are knurled to insure a positive grip.

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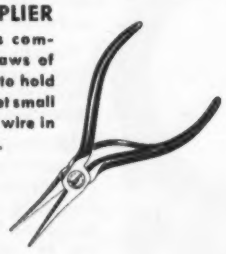
DUCK BILL PLIER
306-5-½—This compact plier has jaws of sufficient width to hold small springs, yet small enough to form wire in confined places.



This Klein Pocket Tool Guide gives full information on all types and sizes of Klein Pliers. A copy will be sent without obligation.

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at the known frequency. The vibrator developed for the purpose utilizes two pairs of large magnetron magnets, with coils surrounding their poles. These coils are energized by a 30-watt audio oscillator and amplifier set.

Rated operating voltages are applied during the test, with a 10,000-ohm resistor in the plate circuit. The a-c voltage drop across this resistor is measured with a vtvm as an indication of the extent to which the tube is reacting to the 40-cycle vibration frequency. At the right of the operator on the vibration test set is a 16-socket rack for preheating the tubes, to speed up the actual test.

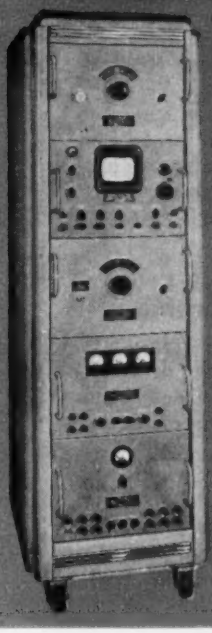
In a more elaborate vibration test

Closeup of electromagnetic-type vibration exciter. Use of two sockets permits vibrating tubes in two planes 90 degrees apart. Direction of motion is in and out of the field coil, just as in a loudspeaker voice coil

set used to measure any change in plate current during either 2.5 g or 15 g under complete normal operating conditions, a standard vibration exciter made by MB Mfg. Co., New Haven, Connecticut, is mounted on a large concrete block. The exciter employs a voice coil and field construction similar to that of an electrodynamic loudspeaker. Direct current for the field coil is obtained from a power supply in an adjacent rack, and variable-frequency audio power for the voice coil is obtained from a Hewlett Packard 202D audio oscillator feeding a 500-watt amplifier. Most tests are conducted at either 25 or 40 cps.

This test setup is used for

Polarad
PRECISION LABORATORY INSTRUMENTS



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10 MC to 21,000 MC

The Model LSA is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an rf signal.

Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MC display at all frequencies.
- Tuning dial frequency accuracy 1 percent.
- No Klystron modes to set.
- Broadband attenuators supplied from 1 to 12 KMC.
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- 5 inch CRT display.

Model LSA

The instrument consists of the following units:

Model LTU-1 RF Tuning Unit—10 to 1000 MC.
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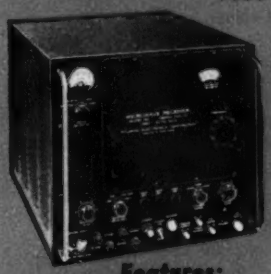
Model LTU-3 RF Tuning Unit—4460 to 16,520 MC.
Model LTU-4 RF Tuning Unit—15,000 to 21,000 MC.
Model LDU-1 Spectrum Display Unit.
Model LPU-1 Power Unit.
Model LKU-1 Klystron Power Unit.

MICROWAVE RECEIVERS

1000—10,750 mc



Four microwave receivers of high sensitivity, wide tuning range and selectivity. Image rejection is greater than 60 db. Gain stability better than ±2 db, permits application as a field intensity meter. Extra large dials enable frequency to be clearly read to an accuracy of 2%. Video bandwidth is 3.0 mc. Input power required is 105-125 v, 50/1000 cps.

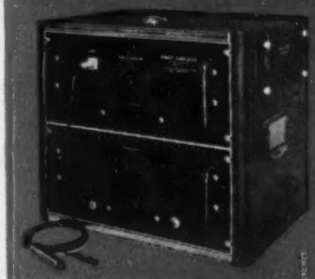
Features:

- Single Dial Tuning
- Low Noise Figure
- Tracked R. F. Preselection, Triple-Tuned
- Linear Db Output Indication
- AM-FM Reception
- Video Output — 10 v Pulse across 100 ohms
- Audio — BFO
- Recorder Output
- Provisions for Using External Attenuators in I.F. Channel
- Frequency Calibration Accuracy — 2%
- Separate Audio & Video Channels
- AFC
- Calibrated Tuning Meter

WIDE BAND VIDEO AMPLIFIER

Model VT 10 CPS to 20 MC

Designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of short duration and rise time. Excellent for TV, both black and white and color applications.



Model VT

Features:

- Flat frequency response from 10 cps to 20 mc ±1.5 db.
- Uniform time delay of .02 microseconds.
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase linear with frequency over entire band.

MICROWAVE SIGNAL SOURCES

Models SSR, SSL, SSS, SSM, SSX
634 MC to 10,750 MC

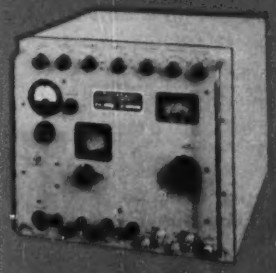
For use as a reliable source of microwave energy in transmission loss measurements, standing wave determination, etc. Unidial Control for accuracy and ease of operation. Direct reading (no mode charts to consult). Frequency determination accurate to 1% through use of present calibration and temperature compensated klystrons.

Five Microwave Signal Sources are available to cover the frequency range from 634 MC to 10,750 MC. Units ruggedly constructed, mounted on aluminum castings to insure mechanical stability. Klystron reflector voltage automatically tracked with tuning of the klystron cavity to provide unidial control. Signal sources supplied complete with klystron.

MICROWAVE SIGNAL GENERATOR

Model MSG-4

7,000 mc — 10,750 mc



Polarad's Microwave Signal Generator, Model MSG-4, is an ideal source of an accurately known signal voltage, precisely modulated. Sensitivity, frequency and performance of radio and radar equipments in the frequency range from 7 to 10.75 kmc can be readily measured on this continuously variable, direct reading signal generator.

Features:

- Continuous tuning
- One tuning control
- Tuning dial accuracy — 1%
- No Klystron modes to set
- Accurate stable power
- Non-contacting shorts guarantee long life
- Modulation — Internal Pulse, FM and external
- Sync output — delayed and undelayed.

Polarad Electronics Corporation

100 METROPOLITAN AVE., BROOKLYN 11, N. Y. • STagg 2-3464

See us at Booth 2-511 Radio Engineering Show

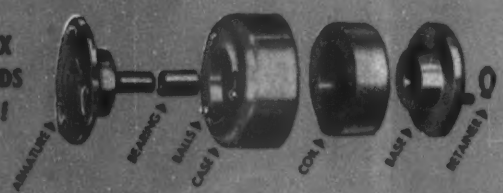
LEDEX ROTARY SOLENOIDS

...give positive, powerful snap action!

here's how a **LEDEX ROTARY SOLENOID** *operates...*

The magnetic pull moves the armature along the Solenoid axis. This action is efficiently converted into a rotary motion by means of ball bearings on inclined races. The inclined ball races are made to compensate for the magnetic pull increase as the Solenoid air gap closes, thereby providing substantially constant torque throughout the Solenoid stroke. The rotary snap-action power of the Ledex can be efficiently harnessed with a minimum of linkages, through the use of one or more standard features available on all models.

here's why **LEDEX ROTARY SOLENOIDS** *are dependable!*



As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled.

The copper wire coil, the heart of the Solenoid, was developed especially for this product. It is wound by a precision winding process that puts a maximum amount of magnet wire into available space . . . giving tremendous power to compact Ledex Rotary Solenoids.

six basic **LEDEX ROTARY SOLENOIDS** *to choose from!*

Model Number	2	3	5	6	7	8
Diameter	1⅛"	1⅜"	1⅞"	2⅛"	2⅞"	3⅜"
Torque lb.-in.*	½	1	5	10	25	50
Weight lbs.	⅛	¼	½	1	2¼	4¼

*45° stroke intermittent duty.

Engineering data is available upon request. Write for descriptive literature today!

G. H. Leland INC.

123 WEBSTER STREET, DAYTON 2, OHIO

sampling inspection only, being too costly and delicate for production purposes. Two sockets are provided, oriented 90 degrees to check vibration in two planes.

Wire-Stripping Machine

CONTINUOUS uniform movement of wire and accurate timing of operations are features of a new wire-stripping machine constructed by Jeffers Electronics Inc.

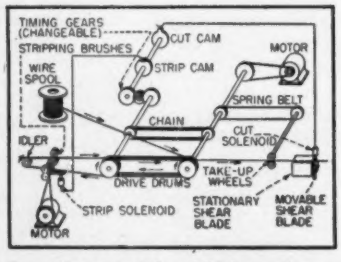
The machine was designed to handle wire from B&S No. 20 to B&S No. 32, in lengths from 2 to 48 inches. The length of the stripped end is adjustable from zero to the whole length of the cut wire.

The change in length of the cut wire is made by changing the gears, which changes the speed and the time for the cam shaft to make one complete turn. The cam that controls the cutting of the wire is a simple one-point cam which can be located in any angular position.

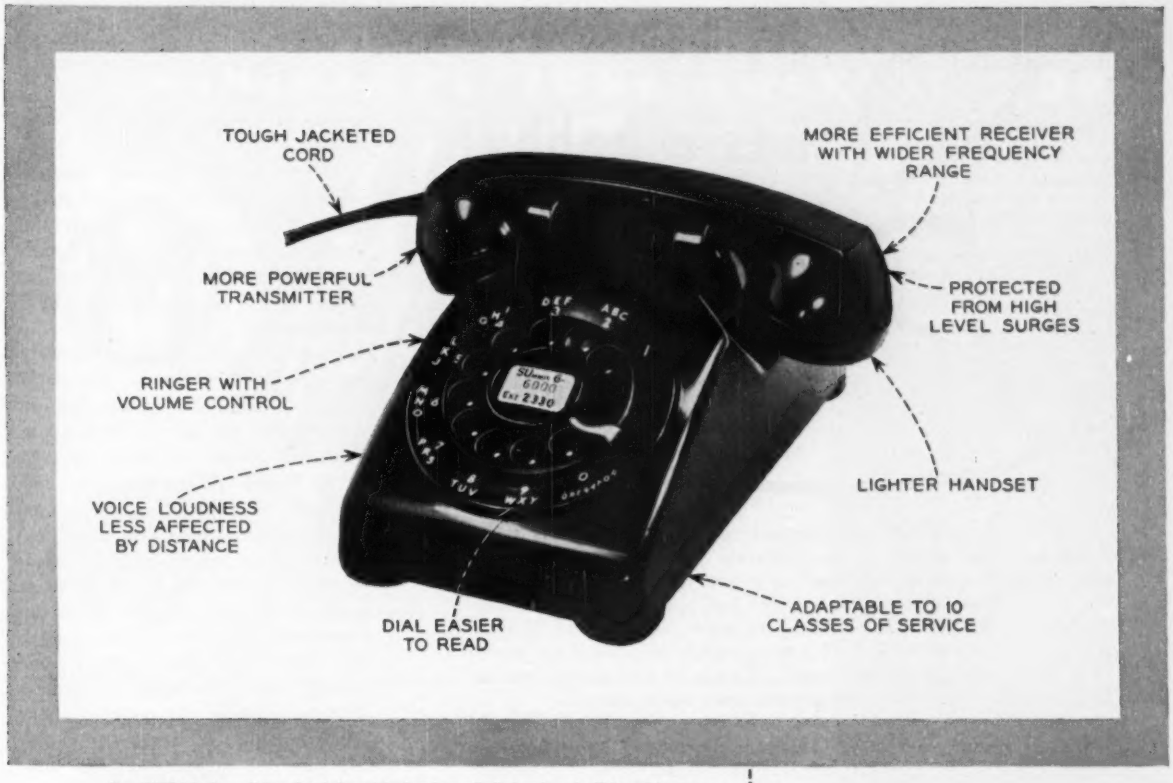
The cam which controls the stripping is a double cam that can be adjusted to control the time or the distance the wire is stripped. Special cut cams can be used which will permit stripping of the wire at one or more points between the cut ends.

The wire is pulled from the supply spool and makes one loop around two driving drums, then goes around the idler wheel and between the two stripping brushes.

The stripping brushes are small, round brushes that are driven at high speed and are in contact on their outside diameter. A solenoid is connected to the lower brush



Operating principle of high-speed continuous wire stripping and cutting machine, in which gear-driven cams control operation of the stripping and cutting solenoids


TOUGH JACKETED CORD
MORE EFFICIENT RECEIVER WITH WIDER FREQUENCY RANGE
MORE POWERFUL TRANSMITTER
PROTECTED FROM HIGH LEVEL SURGES
RINGER WITH VOLUME CONTROL
LIGHTER HANDSET
VOICE LOUDNESS LESS AFFECTED BY DISTANCE
ADAPTABLE TO 10 CLASSES OF SERVICE
DIAL EASIER TO READ

New "500" telephone. It has already been introduced on a limited scale and will be put in use as opportunity permits, in places where it can serve best. Note new dial and 25 per cent lighter handset.

It adds miles to your voice

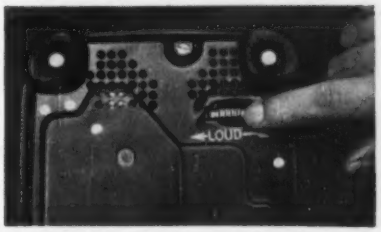
For years the telephone you know and use has done its job well—and still does. But as America grows, more people are settling in suburban areas. Telephone lines must be longer; more voice energy is needed to span the extra miles.

Engineers at Bell Telephone Laboratories have developed a new telephone which can deliver a voice ten times more powerfully than before. Outlying points may now be served without the installation of extra-heavy wires or special batteries on subscribers' premises. For shorter distances, the job can be done with thinner wires than before. Thus thousands of tons of copper and other strategic materials are being conserved.

The new telephone shows once again how Bell Telephone Laboratories keeps making telephony better while the cost stays low.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.



Adjustable volume control on bottom of new telephone permits subscriber to set it to ring as loudly or softly as he pleases. Ring is pleasant and harmonious, yet stands out clearer.

QUICK FACTS ON NEW TELEPHONE

Transmitter is much more powerful, due largely to increased sound pressure at the diaphragm and more efficient use of the carbon granules that turn sound waves into electrical impulses.

Light ring armature diaphragm receiver produces three times as much acoustic energy for the same input power. It transmits more of the high frequencies.

Improved dial mechanism can send pulses over greater distances to operate switches in dial exchange.

Built-in varistors equalize current, so voices don't get too loud close to telephone offices.

Despite increased sensitivity of receiver, "clicks" are subdued by copper oxide varistor which chops off peaks of current surges.

MILO has a hobby!

A difficult but fascinating one. Works this way. Long in advance we try to calculate just what components our industrial users will need in a hurry.

How many, of what size and specification, of what type of part, will you be likely to want most often? Which parts, though unusual, will you nevertheless need on occasion for your special purposes? Which of the many brands we can supply will have the greater user acceptance?

We have no crystal ball. No computers; (though we supply you with parts to make them). All we have is experience in component supply; awareness of new developments — gained from study and conversation with men in the design and application fields of the art; constant effort at seeking out sources; evaluating available shipping methods; and a willingness to risk an occasional oversupply.

Here's a hobby that helps you! It doesn't throw us often. We get a wonderful satisfaction when we can answer you, "In Stock! How many do you want."

check your requirements:

Batteries	Hardware	Sockets
Cable & Connectors	Meters	Solder & Irons
Capacitors	Panels & Racks	Speakers
Chassis	Pilot Assemblies	Switches
Chokes	Power Supplies	Terminal Strips
Coils	Power Controls	Test Instruments
Controls	Reactors	Tools
Diodes, Germanium & Silicon Crystal	Receptacles	Transformers
Fuses	Rectifiers	Tubes, Regular & Special Purpose
Jacks & Plugs	Relays	Voltage Regulators
Knobs	Resistors	Wire & Miscel. Supplies
	Shields & Tubing	

JAN-APPROVED COMPONENTS

FREE INDUSTRIAL TUBE BOOKLET

Chief Engineers, Purchasing Agents, Purchasing Executives! Write now if you haven't received our Industrial Electronic Tube Booklet #EB. Use company letterhead and state your title. Address Dept. E-2.

the ONE source for ALL your electronic needs

MILO RADIO & ELECTRONICS CORP.
Electronics for Industry
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Teletype NY1-1839 • Wire MILO-WUX-N.Y. • Cable MILOLECTRO-N.Y.

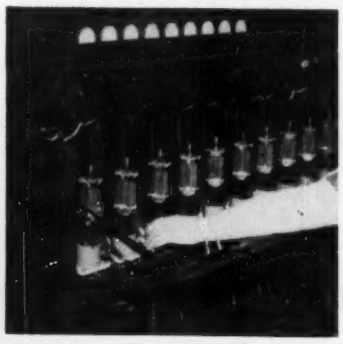
bearing so that the lower brush can be pulled away from the upper brush, permitting the wire to pass between them without being stripped.

After passing between the two stripping brushes, the wire makes three loops around the two driving drums. These two driving drums are connected by a chain and are driven at a constant speed by a drive motor.

The wire, after leaving the driving drums, is pulled to the cutoff part of the machine by two take-up wheels that are driven by a spring belt which keeps tension on the wire at all times. Here the wire goes through a cutting arrangement which consists of a stationary shear block and a movable shear blade which is round and has a series of holes about the outside diameter. The wire passes through the hole in the stationary shear block and through one of the holes in the movable shear blade. In operation, the power solenoid advances the shearing disc the spacing of one hole, which cuts the wire off and allows the new wire to push out through the next hole in the shearing disc. The length of cut is adjusted by rotating the cam that controls the cut solenoid.

Testing High-Voltage Tubes

A TEST console developed for power tubes makes plate voltage connections automatically to the top caps of ten tubes at a time when the top cover is lowered, and applies voltage automatically only when the operator has pushed the front



Safety-first console developed for testing ten large tubes at a time without risk of electrical shock to the operator

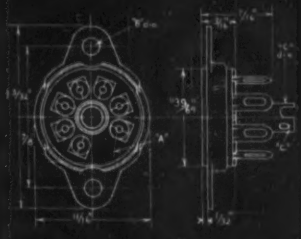
MINIATURE TUBE SOCKETS FOR UHF Applications

Methode design and tooling, completed well in advance of the thaw in commercial ultra-high frequency station allocations, makes available miniature sockets especially designed to minimize inductance and capacity in tuner and converter tube applications. Miniaturization of contacts and insulator permits 50% reduction in distance between lead terminations and tube seal.

Available with several types of standard mountings, superior performance in these precision products is assured by METHODE'S high production experience in their manufacture.

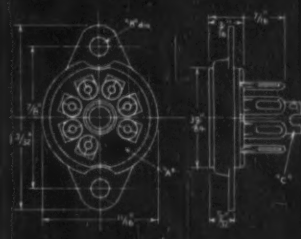
Sub-Panel Saddle

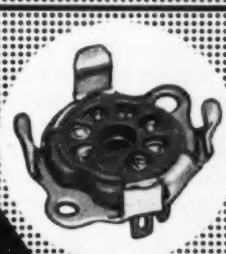
PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-153-093	Mica Phenolic	3/32"	
SMA-153-093	Alkyd	3/32"	
SMU-153-125	Mica Phenolic	1/8"	
SMA-153-125	Alkyd	1/8"	
SMU-154-093S	Mica Phenolic	3/32"	1/8" D x 3/8" L
SMA-154-093S	Alkyd	3/32"	1/8" D x 3/8" L
SMU-154-125S	Mica Phenolic	1/8"	1/8" D x 3/8" L
SMA-154-125S	Alkyd	1/8"	1/8" D x 3/8" L



Top Panel Saddle

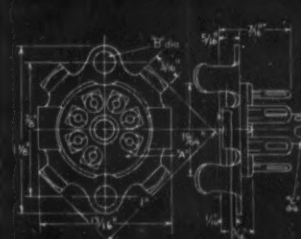
PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-155-093	Mica Phenolic	3/32"	
SMA-155-093	Alkyd	3/32"	
SMU-155-125	Mica Phenolic	1/8"	
SMA-155-125	Alkyd	1/8"	
SMU-156-093	Mica Phenolic	3/32"	1/8" D x 3/8" L
SMA-156-093	Alkyd	3/32"	1/8" D x 3/8" L
SMU-156-125S	Mica Phenolic	1/8"	1/8" D x 3/8" L
SMA-156-125S	Alkyd	1/8"	1/8" D x 3/8" L

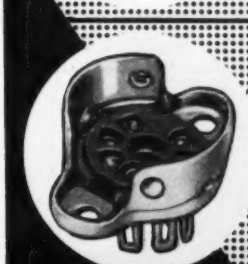




Top Panel Mount "Snap-In" Shield Base

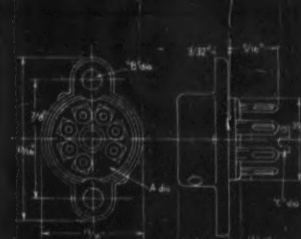
PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-185-093	Mica Phenolic	3/32"	
SMA-185-093	Alkyd	3/32"	
SMU-185-125	Mica Phenolic	1/8"	
SMA-185-125	Alkyd	1/8"	
SMU-186-093S	Mica Phenolic	3/32"	1/8" D x 3/8" L
SMA-186-093S	Alkyd	3/32"	1/8" D x 3/8" L
SMU-186-125S	Mica Phenolic	1/8"	1/8" D x 3/8" L
SMA-186-125S	Alkyd	1/8"	1/8" D x 3/8" L





Top Panel Mount "Twist-On" Shield Base

PART NO.	"A" INSULATOR MATERIAL	"B" MOUNTING HOLES	"C" CENTER SHIELD
SMU-175-093	Mica Phenolic	3/32"	
SMA-175-093	Alkyd	3/32"	
SMU-175-125	Mica Phenolic	1/8"	
SMA-175-125	Alkyd	1/8"	
SMU-176-093S	Mica Phenolic	3/32"	1/8" D x 3/8" L
SMA-176-093S	Alkyd	3/32"	1/8" D x 3/8" L
SMU-176-125S	Mica Phenolic	1/8"	1/8" D x 3/8" L
SMA-176-125S	Alkyd	1/8"	1/8" D x 3/8" L



Material Specifications

Insulators are available in mica-filled phenolic (type MFE) or Alkyd ≡420 production capacity material. Contacts are low resistance copper base alloy with cadmium finish (silver if specified). Mounting saddles and bases are cadmium plated steel.

NOVAL SOCKETS SIMILAR TO THE ABOVE ALSO AVAILABLE.

METHODE Manufacturing Co.

2021 West Churchill St. Chicago 47, Illinois

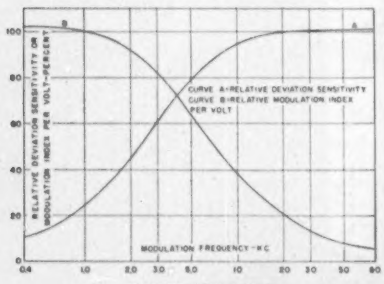
Production capacity on this new product is being rapidly increased to meet industry demand

STABLE...RELIABLE...COMPACT

This is the most rugged and lightest weight crystal controlled transmitter on the market and is unusually stable under extremes of temperature, vibration, altitude and acceleration. The transmitter produces a two watt frequency deviated signal within the telemetering band of 215 to 235 mc.

SPECIFICATIONS

OUTPUT (R.F.):
Load Impedance.....50.0 ohms nominal
Carrier Frequency.....215 mc to 235 mc
Power Output.....2 watts nominal


RELATIVE DEVIATION SENSITIVITY OR MODULATION INDEX PER VOLT—PERCENT
CURVE A-RELATIVE DEVIATION SENSITIVITY
CURVE B-RELATIVE MODULATION INDEX PER VOLT
MODULATION FREQUENCY - KC
FIG. 1 TXV-13 TRANSMITTER

TYPICAL OPERATION:
"A" Voltage.....6.0 V d.c. or r.m.s. a.c.
"A" Current.....1.2 amps
B+ Voltage.....180 V d.c.
B+ Current.....85 ma
Power Output.....2.0 watts
Distortion.....1% total harmonic distortion for modulation index of 4

INSTALLATION:
Size.....1.5" high x 2.75" wide x 4.5" long
Weight.....1.1 pound
Connectors: Power and Modulation R.F. Output....Winchester M5P (mating M5S with H-19 hood furnished) UG-625/U (mating UG-88/U furnished)

When ordering, specify model number and output frequency desired

Write for complete information.

Pacific Division Bendix
Bendix Aviation Corporation
NORTH HOLLYWOOD CALIF.

EAST COAST OFFICE: 475 FIFTH AVE., NEW YORK 17, N.Y.
EXPORT DIVISION: BENDIX INTERNATIONAL, 72 FIFTH AVE., NEW YORK 11, N.Y.

safety cover all the way up. Pairs of shorting plugs on the front screen mate into jacks on the top cover to complete the circuit for testing the tubes in this arrangement, developed by Westinghouse.

Phosphor bronze strips mounted on an insulating sheet under the top cover make contact with the top caps of the tubes. Each strip is double-ended, to take care of an additional ten tubes for which a second row of ten sockets is provided. This permits using the test set for tubes requiring another type of socket.

Selection of Casting Resins

THE THREE principal applications for casting resin in connection with the production of electronic equipment are for circuit and component immobilization, for high-voltage insulation and for moisture protection. The five most important properties used as criteria when choosing a resin for one of these applications are dissipation factor, dielectric constant, dielectric strength, heat-distortion temperature and moisture absorption. Tables I and II show at a glance the best resin for each requirement and give pertinent properties.

The general casting procedure for encapsulating electronic circuits or components is diagrammed in Fig. 1. Some resins will require heat during mixing, as specified in manufacturer's instructions. Various techniques are used for releas-

Table I—Selection of Casting Resins

For Circuit and Component Immobilization:
- High Temperature—GRX-71
- High Dielectric Strength—AN-5; R-1433
- Low Loss—NBS; Stycast
- Low Dielectric Constant—Stycast; AN-5; NBS
- Low Moisture Absorption—NBS

For High-Voltage Insulation:
- Stycast; AN-5; Kriston; NEL-177; RLS-3869; EC 10C-10CM; R-1433

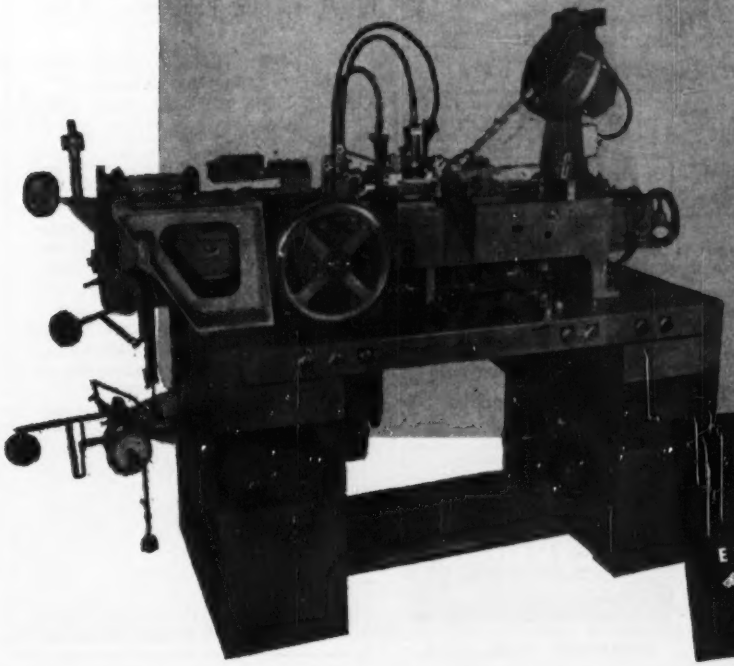
For Moisture Protection:
- Stycast; Epon RN-34;AN-5; NBS

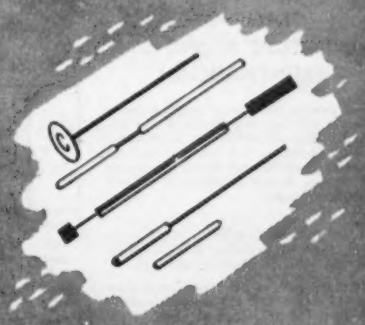
Here's how to get production quantities of precision components for TRANSISTORS · RADIO TUBES HERMETIC SEALS · LAMPS

Now it is possible for progressive manufacturers to produce their own precision electronic components. For example, the Automatic Lead Wire Welding Machine, shown below, was recently designed and built by Kahle to produce 12,000 3-piece leads per hour for miniature receiving tubes. Although this machine, Model 2148, is designed to make standard welds, it is but one step from a machine to produce leads for electronics' latest wonder... the transistor. In addition, Kahle has produced a fully automatic Filament Making and Tabbing Machine, Model 2036, that produces from 1,200 to 3,000 filaments per hour depending upon wire diameter.

These machines reflect Kahle's ability to design and build special-purpose machinery to meet any given specifications. Regardless of your current production problems, learn... without obligation... how Kahle's more than 40 years of practical experience can benefit you.

For specific information, write Kahle... now.





Kahle
ENGINEERING COMPANY
1310 SEVENTH STREET
NORTH BERGEN, N. J.

Winchester Electronics

SOLVES "MINIMUM" WEIGHT AND SPACE PROBLEMS

SUB-MINIATURE
Single- and Double-Contact
CONNECTORS

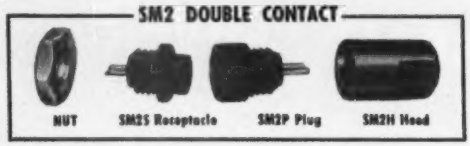
MONOBLOC* CONSTRUCTION eliminates unnecessary creepage paths, moisture and dust pockets and provides stronger molded parts.

MOLDED MELAMINE BODIES (in accordance with MIL-P14a) – mineral filled – are fungus-proof and provide mechanical strength as well as high arc and dielectric resistance.

CONTACTS PRECISION MACHINED: Pins from brass bar (QQ-B611) and Sockets from spring temper phosphor bronze bar (QQ-B746a). They are gold plated over silver for consistent low contact resistance, reduction of corrosion and aid in soldering.

SM1 SINGLE CONTACT

SM2 DOUBLE CONTACT



POLARIZATION: Body design of the "SM2" permits engagement in one position only.

RACK & PANEL MOUNTING: Either plug or receptacle may be panel mounted with a ¼-28 cadmium plated brass nut. A melamine hood protects soldered wires.

SUB-MINIATURE RECTANGULAR CONNECTORS

These connectors also employ standard Winchester Electronics features:

TERMINALS

STAND-OFF
MINIATURE STAND-OFF
FEED-THROUGH

Shown here are but a few of the large line of terminals now available and which are particularly useful in limited space applications: 1) As a substantial, well insulated electrical tie point (Stand-off type) and 2) For passing high voltage through a chassis or a panel (Feed-through type).

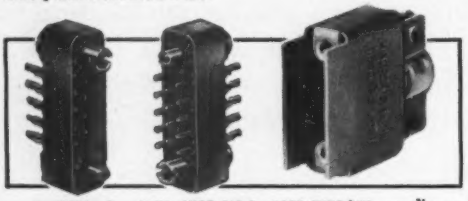
MOLDED MELAMINE BODY: (MIL-Spec. P-14, Type MTS-G-2 or G-3) for high dielectric and mechanical strength.

TERMINALS: *Solder Type* (Bifurcated or Turret) brass, hot tin dipped; *Screw Thread Type* (Tapped insert or Threaded stud) No. 4-40 or No. 6-32, brass, cadmium plated, clear iridite finish.

MOUNTING METHOD: *Rivet*, hollow aluminum shank (.094" O.D.) assembled by swaging or spinning; *Tapped Insert*, brass, cadmium plated, clear iridite finish, assembled with No. 4-40 or No. 6-32 standard machine screw; *Threaded Stud*, brass, cadmium plated, clear iridite finish, assembled with No. 4-40 or No. 6-32 nut.

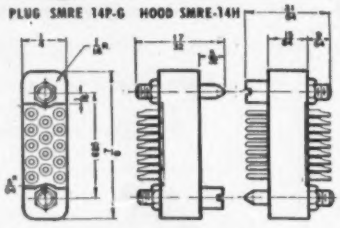
BREAKDOWN VOLTAGE:

Stand-off Body Length	D.C. Voltage
7/32"	7,000 V
3/8"	14,000 V
17/32"	22,000 V
19/32"	24,000 V
Feed-through Creepage Length	
5/32"	4,500 V
9/32"	8,000 V



RECEPTACLE SMRE 14S-G — PLUG SMRE 14P-G — HOOD SMRE-14H

Photo and Drawing of SMRE-14 actual size. Other sizes determined by number of contacts.



PHYSICAL AND ELECTRICAL DATA

Recept. Code No.	Plug Code No.	No. of Contacts	Solder Cup Dia. In.	Weight Oz. Rec.	Plug	Hood	D.C. Volts Breakdown Connector Engaged: Sea Level Normal Humidity Between Contacts	Contacts to Gnd.	60,000 Ft. Altitude Between Contacts	Contacts to Gnd.
SM1S	SM1P	1	.043	.02	.04	.02	....	1400	...	1750
SM2S	SM2P	2	.0225	.02	.02	.02	1400	2400	800	1100
SMRE 7S-G	SMRE 7P-G	7	.0225	.1	.1	.1	2450	2050	950	675
SMRE 14S-G	SMRE 14P-G	14	.0225	.1	.2	.1	2450	2050	950	675
SMRE 20S-G	SMRE 20P-G	20	.0225	.2	.2	.2	2450	2050	950	675
SMRE 26S-G	SMRE 26P-G	26	.0225	.2	.2	.2	2450	2050	950	675
SMRE 29S-G	SMRE 29P-G	29	.0225	.2	.2	.2	2450	2050	950	675
SMRE 34S-G	SMRE 34P-G	34	.0225	.2	.2	.2	2450	2050	950	675

If Gold Pins are not desired omit "G" in above Code Numbers.

"Trade Mark
Pats. Pend.

Write for dimensions and other details including terminal types and mounting methods.

West Coast Branch:
1729 WILSHIRE BLVD.
SANTA MONICA, CALIF.

WINCHESTER ELECTRONICS
INCORPORATED

GLENBROOK, CONN., U.S.A.

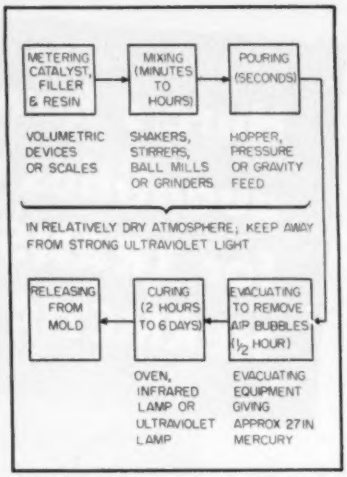

METERING CATALYST, FILLER & RESIN
MIXING (MINUTES TO HOURS)
POURING (SECONDS)
VOLUMETRIC DEVICES OR SCALES
SHAKERS, STIRRERS, BALL MILLS OR GRINDERS
HOPPER, PRESSURE OR GRAVITY FEED
IN RELATIVELY DRY ATMOSPHERE; KEEP AWAY FROM STRONG ULTRAVIOLET LIGHT
RELEASING FROM MOLD
CURING (2 HOURS TO 6 DAYS)
EVACUATING TO REMOVE AIR BUBBLES (½ HOUR)
OVEN, INFRARED LAMP OR ULTRAVIOLET LAMP
EVACUATING EQUIPMENT GIVING APPROX 27 IN MERCURY

FIG. 1—General casting process for circuit and component embedment

ing the cured product from the mold. When expendable molds, made of wax or some similar material, are used it may be necessary to add additional operations such as melting away the mold after the casting is cured.

Curing times vary greatly with choice of resin and curing conditions, hence examples of recommended cure conditions are given below for typical casting resins. These cure conditions are taken

Table II—Properties of Resins

Resin, Mfr, Temp Range & Max Freq:
Araldite Resin B (Ciba Co.); 30 C to 140 C; freq unknown.
Bakelite C-8 with Inert Filler (Bakelite Corp.); −64 C to +80 C; 400 cps.
Hysol 6000 PR, 6020, 6500 and 6501 (Houghton Labs.); −55 C to +150 C; 3,000 mc.
Laminac 4116 (American Cyanamid Co.); −45 C to +100 C; 50 mc.
N. E. L. No. 177 (U. S. Navy Electronics Lab.); −54 C to +100 C; 200 mc.
Paraplex P-13 (Rohm and Haas); −40 C to 100 C; freq unknown.
Paraplex P-43 (Rohm and Haas); −45 C to +100 C; 50 mc.
Polystyrene (Emerson and Cuming); up to 80 C; 1,000 cps.
Selectron 5003 (Pittsburg Plate Glass Co.); −65 C to +125 C; 30 mc.
Selectron 5016, 5081, 5208 (Pittsburg Plate Glass Co.); −55 C to +71 C; 30 mc.
Selectron 5209 (Pittsburg Plate Glass Co.); −65 C to +120 C; D-C.
Stypol 503 (H. H. Robertson Co.); −55 C to +100 C; freq unknown.

Picture distribution amplifier unit as well as synchronizing generator and power supply units are mounted on Grant Industrial Slides. Units are normally retracted but roll out for servicing.

Grant Slides... Smooth, Fast and Efficient!

DuMont's problem was space

Compactness was the prime requirement for the DuMont Telecruiser — a mobile unit which had to duplicate actual studio operating conditions in every respect.

It was absolutely necessary to confine the servicing operations of various units to a limited area. Consultation with Grant representatives resulted in the selection of the proper (Electronic Equipment) Slides for the DuMont Telecruiser.

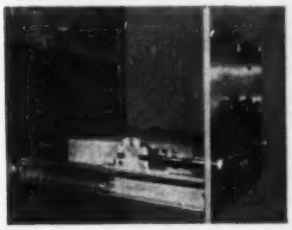
Do you have a servicing and maintenance problem?

Grant Research and Development facilities are at your service. Let us assist you in the choice and application of Grant Slides to your equipment. Engineering liaison is available from the planning stage through the production processes.

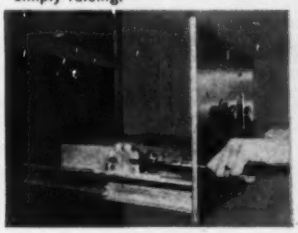
GRANT INDUSTRIAL SLIDES

a product of the engineering design department of
Grant Pulley and Hardware Company
31-73 Whitestone Parkway, Flushing, New York.
Write for information . . . consult on any problem

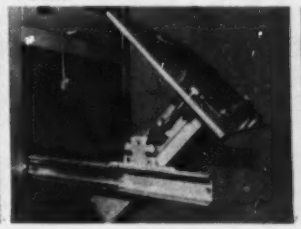
1. FULL EXTENSION — Continous ball bearing action permits smooth, non-jar chassis removal. Locks in fully extended position, must be unlocked to return.



2. PIVOT RELEASE — Withdrawing release rods disengages them from quadrant mechanism, enables perfectly balanced unit to be tilted by simply raising.

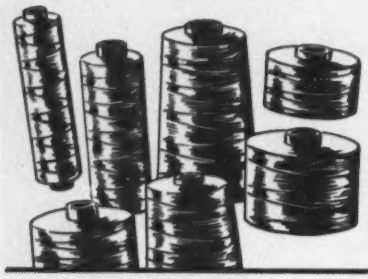


3. 45° PIVOT — Unit locks in 45 degree or 90 degree position. Special pivoted positions can be obtained to fit individual requirements.

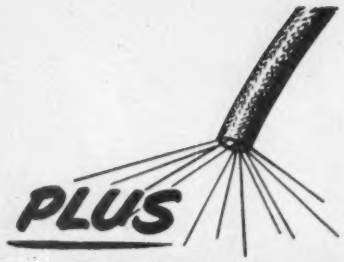


4. FULL TILT — Maintenance and repairs easily made. Access to component is gained in a few seconds. Special slides can provide plus or minus 90° tilt.

STRONG, INERT AND HEAT RESISTANT GLASS

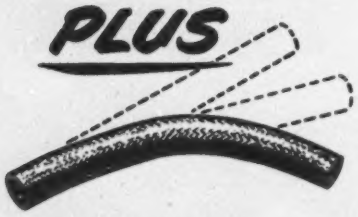


PLUS



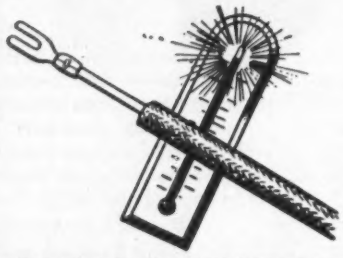
"SILVERFLEX" PROCESSED BRAID FOR NON-FRAYING

PLUS



RESILIENT, SEMI-INORGANIC SILICONE RUBBER *EQUALS* PERMANENT AND EXTREME FLEXIBILITY

AND RESISTANCE TO ASSEMBLY ABUSE



FOR HIGH HEAT CLASS "H" ELECTRICAL INSULATION OF WIRE LEADS

DIEFLEX® silicone rubber treated flexible glass tubings and sleevings are made in NEMA Grades A-1, B-1, C-1, and C-2, in sizes No. 24 through 1" in standard natural white color. Other Dieflex products guaranteed to meet or surpass all applicable NEMA and ASTM standards include varnished cotton tubings and saturated cotton sleevings, varnished glass tubings and saturated glass sleevings, "Vinylglas" vinyl-coated glass tubings and sleevings, and silicone varnished glass tubings and saturated glass sleevings.

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*Local Stocks Available

PRODUCTION TECHNIQUES (continued)

from manufacturer's data; faster cures may be obtained at higher temperatures, but size and shape of the casting should be considered before attempting an accelerated cure. The resins listed here are only representative of those available, hence this is by no means a complete listing.

Curing Times and Catalysts

Stycast (Emerson & Cuming Co.)—5 days at room temperature, then 24 hours at 60 C followed by 4 hours at 85 C. Catalyst—benzoyl peroxide.

Epon RN-34 (Shell Development Co.)—24 hours at 60 C, then 2 to 3 hours at 100 C. Catalyst—pipiridine.

AN-5 (developed by National Bureau of Standards)—1 day at 50 C. Catalyst—1. benzoyl peroxide; 2. cobalt dryer; 3. Pro-A.

NBS (developed by National Bureau of Standards) — Room temperature for gelation period, followed by 8 to 10 hours at 50 C to 60 C. Catalyst—1. Uniperox 60; 2. benzoyl peroxide.

NEL (Rohm & Haas Co.; developed by Naval Electronics Lab, San Diego, Calif.)—8 hours refrigerated, then 2 hours at room temperature and 10 hours at 45 C. Catalyst—Uniperox 60.

Selectron 5000–5200 (Pittsburgh Plate Glass Co.)—6 hours gelation at room temperature, then 15 to 30 minutes at 250 F to 260 F. Catalyst—1. Uniperox 60; 2. benzoyl peroxide.

Resin 40 (Emerson & Cuming Co.)—36 hours at room temperature, then 4 hours at 85 C. Catalyst—benzoyl peroxide.

R-1433 (Minnesota Mining & Mfg. Co.)—Gelation cure 2 to 4 hours at 250 F to 275 F, then final cure 2 to 4 hours at 300 F to 325 F. Catalyst— phthalic anhydride.

RLS-3869 (Minnesota Mining & Mfg. Co.)—2 to 4 hours at 250 F to 275 F, then 1 to 2 hours at 300 F to 325 F. Catalyst—diallyl phthalate.

EC 10C-10CM (Emerson & Cuming Co.)—Cure time. not given Catalyst—Emerson & Cuming Catalyst No. 6.

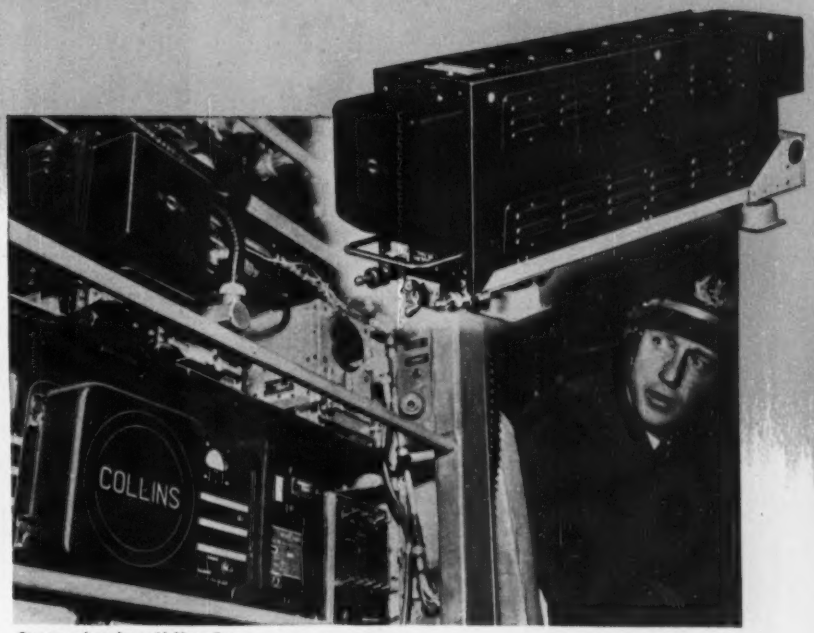
It should be noted that P-43, the Selectron resins and EC 10C-10CM are air-inhibited, hence the surface of the casting exposed to air will

COLLINS AIR-NAVIGATION RECEIVERS USE G-E 5-STAR TUBES FOR DEPENDABILITY!

GENERAL ELECTRIC is a large supplier of high-reliability tubes to Collins Radio Company, who use G-E 5-Star types widely in the 51R-series receivers for air navigation and communications.

25 tubes, or practically the entire complement of the chassis, are high-reliability types. "Every 51R component has to do its job under the toughest flight conditions," says J. H. Hamilton, Manager, Aviation Sales. "So we specify high-reliability tubes all along the line. The result is equipment with maximum dependability."

G-E 5-Star Tubes have an extensive record of dependable tube service to airlines and to the armed forces. The Collins application is further evidence of the ability of these tubes to solve your electronic equipment problems.



Courtesy American Airlines, Inc.

AND NOW--G-E 5-STAR SUBMINIATURES!

As the largest supplier of high-reliability tubes—manufacturing the most types, and with outstanding production facilities—General Electric now offers to designers a complete line of ten 5-Star subminiatures.

In all respects, these subminiatures match the premium performance of regular 5-Star types. They are uniformly operable when installed. They are shock-proof . . . extra-dependable . . . long-lived . . . with fewer shorts, fewer heater failures than standard tubes.

Select the right types for *your* new miniaturized equipment from the listing at right! For detailed application facts about 5-Star Tubes—both regular and subminiature—wire or write for new Booklet ETD-548A. *Tube Department, General Electric Company, Schenectady 5, New York.*

SPECIFY THESE 5-STAR SUBMINIATURES!

GL-5718	Medium-mu triode
GL-5719	High-mu triode
GL-5797	Semi-remote-cutoff pentode
GL-5798	Medium-mu twin triode
GL-5840	Sharp-cutoff r-f pentode
GL-5896	Twin diode
GL-5899	Semi-remote-cutoff pentode
GL-5902	Beam power amplifier
GL-6111	Medium-mu twin triode
GL-6112	High-mu twin triode

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

Diamond Anniversary

GENERAL ELECTRIC

163-1A2

Is that a bombsight
in your BASEMENT?
Of course it could be. But it would be a simplified version with its chore associated with controlling the heat for your home, or the deep-freezer, or the automatic washing machine and dryer, rather than computing the point for "bombs away". This is an age of instruments and systems — an age in which the name NORDEN has come to stand for highest precision. Bombsights for the military services yesterday . . . highly advanced equipments for them today . . . still more for the Country's defense — and for industry — tomorrow.
Norden
instruments and systems of highest precision
MILFORD, CONNECTICUT
WHITE PLAINS, NEW YORK

remain tacky after cure.

Recommended fillers that may be used with all resins are powder glass, micronized silica, aluminum powder, calcium carbonate, powdered slate, talc, asbestos, glass beads and powdered mica.

Casting Problems and Examples of Corrective Measures

Cracking of Resin Castings. (1) Amount of promoter was reduced; this lowered temperature during curing and increased setting time; (2) fillers were added, such as asbestos, talc, mica, slate flower or powdered glass; (3) casting resin was modified; (4) casting was cured in temperature-controlled oven; (5) sharp edges or projections were eliminated from articles to be embedded; (6) flexible resins made from epoxides were used; (7) article to be embedded was coated with flexible material such as Silastic 181; (8) curing technique was modified with respect to activation and temperature.

Cracking of Fragile Components. (1) Filler was added to resin; (2) parts were coated with an elastomer before encapsulating.

Excessive Shrinkage of Castings. (1) Filler was added; (2) a maximum amount of rigid resin was used; (3) epoxy resins were used instead of polyesters; (4) materials and curing procedure changed. Maximum shrinkage of Houghton Labs resins is specified to be 2.3 percent.

Casting Adheres to Mold. (1) Use mold release agents, such as silicone grease, Hi-Glo parting lacquer or mineral oil; (2) use molds made of teflon or nylon.

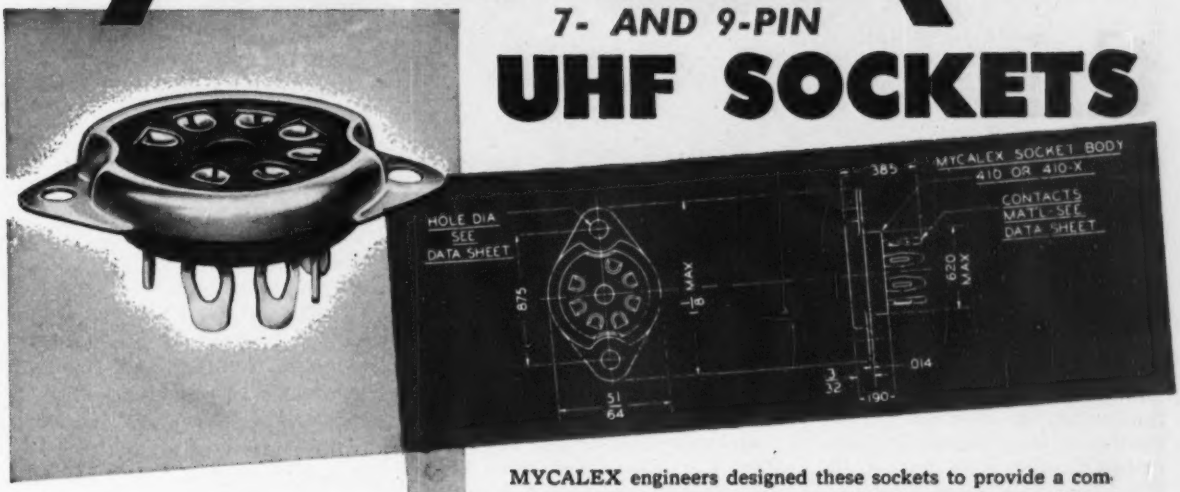
Poor Adherence to Embedded Parts. (1) Prepare metal surfaces more thoroughly; (2) match thermal coefficient of expansion of resin to that of metal by adding fillers; (3) omit insulating tubing from components, as Selectron resin would not adhere to the tubing.

Poor Heat Transfer. (1) Add fillers to improve heat transfer from components to outside of casting; (2) change circuit configuration, so that high-temperature components were near radiating

THE complete answer TO uhf SOCKET PROBLEMS—

"MYCALEX 410"

7- AND 9-PIN UHF SOCKETS



...ELECTRICALLY EFFICIENT!

...MECHANICALLY PERFECT!

- LOW INTER-ELECTRODE CAPACITANCE
- VERY LOW DIELECTRIC LOSS
- HIGH DIELECTRIC STRENGTH
- PERMANENT DIMENSIONAL STABILITY
- NON-HYGROSCOPIC, NON-WARPING

INFORMATIVE DATA SHEETS AVAILABLE!

Write for your complete set, together with loose-leaf binder for instant, easy reference. Your request will automatically assure prompt forwarding of all subsequent Mycalex data sheets and catalog material. Write on company letterhead please.

MYCALEX engineers designed these sockets to provide a complete, yet economical, solution to UHF tube mounting problems. Exhaustive tests have proven their mechanical excellence and high electrical efficiency. The use of "MYCALEX 410" (injection molded glass-bonded mica) with its great dimensional stability permits a minimum amount of dielectric to be used in the body structure. This plus other unique design features results in extremely low inter-electrode capacitance. In addition to its other advantages—high arc resistance, high dielectric strength, nonporosity, etc., "MYCALEX 410" has very low dielectric loss at all frequencies including UHF and thereby offers great advantage over phenolic materials. "MYCALEX 410" operates continuously in temperatures up to 650°F with practically no change in electrical properties or mechanical structure. Soldering operations will not cause body distortion.

MYCALEX TUBE SOCKET CORPORATION

Under exclusive License of Mycalex Corporation of America • 30 ROCKEFELLER PLAZA, N. Y. 20

TROUBLE-FREE CONTACT TERMINALS!

Contact terminals on these sockets are so designed that the effective inductance from soldered connection to the tube base is no greater than if the connection was made directly to the tube pin. Special design results in high contact area pressure that effectively reduces contact resistance. Contact terminals are secured in the body in a manner that permits 90° bending of the tab without weakening.

ALL TYPES OF MOUNTING HARDWARE!

"MYCALEX 410" UHF Sockets, 7 or 9 pin, can be furnished mounted in various standard saddle hardware—regular saddles (top or bottom mounted), saddles with ground lugs, snap or JAN types, permitting the use of radio tube shields.

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this

is of vital interest to everyone who has a

VIBRATION PROBLEM!

Here is a fresh approach to vibration and shock control—an *all-metal* mount! Just look at the careful fabrication of the stainless steel wire cushioning. This is the heart of the new Robinson Met-L-Flex mount. Shock and vibration are absorbed *from every angle*, thereby isolating and protecting the mounted equipment.

Wide Range of Applications

Robinson Met-L-Flex design control can be applied to the mountings for delicate precision equipment or heavy machinery.

Far better vibration control has been sorely needed to keep pace with modern advances in the design and use of electronic and precision equipment. Well, here it is!

Great Cost Savings

Where the new principle of all-metal vibration control is used with Robinson unit mounts or engineered mounting systems it effects decided economy. It not only permits simplified design and construction of equipment, but also contributes to far longer useful life.

Outstanding Performance

Robinson Met-L-Flex mounts were originally developed to meet unprecedented, severe conditions of modern high speed planes.

From take-off to landing a plane's vital equipment is subject to the combined violence of shock and vibration. Sure protection is needed. Met-L-Flex meets such challenges with flying colors, to the great relief of engineers. Moreover, unlike old-fashioned rubber mountings, Robinson Met-L-Flex mounts perform at peak efficiency under any atmospheric conditions. They are not daunted by oil, temperature extremes, or moisture—and the need for replacement due to fatigue is virtually nil.

Proved and Accepted

Robinson mounts have been tested and accepted by more than three hundred electronics, aircraft and industrial manufacturers. With such a background and record of performance, Robinson offers the advice and counsel of its engineers toward finding the best and most economical answer for every problem of vibration and shock.

JUST WRITE AND ASK US

If you are an engineer, architect or manufacturer who would be interested in having more information as to how this new kind of engineered vibration control might help your special problem, we will be glad to hear from you. Drop us a line.

ROBINSON AVIATION INC.

TETERBORO, NEW JERSEY

Vibration Control Engineers

surfaces; (3) use heat radiators.

Fume Hazards. (1) Use convection heating equipment, because of danger of fire when curing with heat lamp because catalyst and promoter are inflammable; (2) install proper ventilation to carry off fumes while mixing, pouring and setting as the fumes are toxic to some operators.

These corrective measures are presented as things to try one after another when a particular problem is encountered. As a rule, not all the corrective measures are necessary; sometimes only one is sufficient to solve the problem.

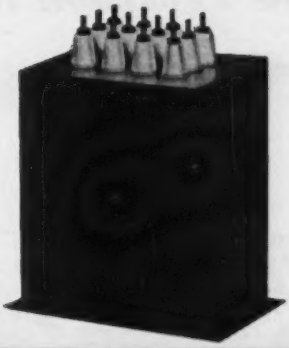
The foregoing information was abstracted from a technical report, "Development and Application of Automatic Assembly Techniques for Miniaturized Electronic Equipment", prepared by Stanford Research Institute for the Wright Air Development Center.

Induction Sealing of Pencil Triodes

IN THE envelope-assembling machine used for pencil triodes at RCA's Harrison, N. J. plant, induction heating is used exclusively for making the required vacuum-tight glass-to-metal seals. The parts making up the assembly are supported on a Nichrome jig which aligns and spaces the parts. Six separate high-frequency generators

Electronic heating generators here speed production of pencil triodes, appearing here as tiny vertical white rods under the work coils

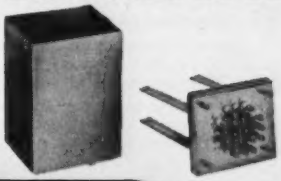
MERIT TRANSFORMERS



BE A LEADER . . .

manufactured with

Heldor CANS & TERMINALS



Heldor Transformer Cans and Bushings are standard components of Merit Transformer Corporation's products. They demand better quality and uniform production—Heldor gives it to them.

More and more of the leading electronic parts manufacturers are now using Heldor's complete "package"—cans with compression-type hermetic-seal terminals ASSEMBLED in can covers. —If you want to cut production costs, save time and eliminate inventory problems, send us specifications for a quotation today.

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Heldor

HELDOR BUSHING & TERMINAL CO., INC.

225 Belleville Avenue, Bloomfield, New Jersey

7 good reasons for specifying MEPCO *Precision Resistors*

MEPCO

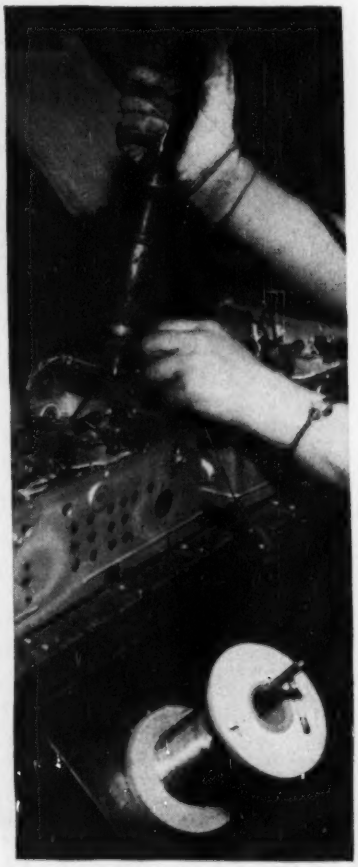
1. Crossover wire insulated from each winding by 2000v. insulation *(patented)*.
2. Special metal molded connecting feature, which bonds end of winding and terminal in a non-corrosive and mechanically secure manner—no solder or flux used.
3. Reversed and balanced PI-windings for low inductance, with use of only the finest resistance alloys.
4. Impregnated with approved fungus, moisture and salt water-proofing compounds.
5. JAN approved non-hydroscopic steatite bobbin, specially treated prior to winding in order to provide additional protection for fine enameled wire.
6. Protective fungi resistant acetate label.
7. Rigid hot solder coated brass terminals for easier soldering.

MEPCO, INC.,
MORRISTOWN, NEW JERSEY

are required, one for each of the six heating positions. The water-cooled work coils are connected to the generators by multiple layers of flexible bonding braid and rubber hose sections are used as water lines, to permit vertical movement of the heating coils. As each tube in turn is indexed to a heating position, the work coil is lowered and automatically energized. Fluorescent lamps fastened overhead with tape glow to indicate that power is on. The electric field is sufficiently strong so that no connections are needed for the lamps.

Brackets on Pallet Hold Auto Radios

SIMPLE angle brackets and straight metal pieces are fastened to plain wood pallets with screws to provide non-slip positioning of the wrap-



Use of inexpensive angle brackets on pallets to position auto radios, and simple support for solder reel. The solder holder can be slid along the bench readily, and may be lifted off when no longer needed

A Guide—for MAGNET WIRE Insulation Removal

TYPES OF WIRE AND STRIPPING METHODS

Type of Winding	DCC	Glass	EC	Formvar-Cotton	PE	HF	HNC	Method of Stripping
Motor Stators	x	x	x	x	x	x	x	Brushing
			x	x	x	x	x	Brushing & Burning
	x		x	x	x	x	x	Welding
						x	x	Chemicals
	x	x	x	x	x	x	x	Scraping
Wound Armatures	x	x	x	x		x	x	Brushing
Wire sizes				x		x	x	Burning & Brushing
8-20 AWG						x	x	Chemicals
						x	x	Scraping
Wound Armatures					x	x	x	Brushing
Wire sizes						x	x	Burning
21-30 AWG						x	x	Hot Solder
					x	x	x	Chemicals
Wound Armatures					x	x	x	Brushing
Wire sizes						x	x	Burning
31-40 AWG						x	x	Chemicals
					x			Sanding

Type of Winding	Paper DCC	Glass	°HNC Form. Cotton	PE	°HNC HF	*Nylon *Celen	Nylon Celanese Over *Nylon *Celen	Nylon Celanese Over HF-°HNC	Silk Over HF-°HNC	Silk Over PE	Method of Stripping
Transformers	x	x	x	x	x						1. Brushing
(large)			x		x						2. Burning & Brushing
&	x		x		x						3. Welding
Solenoids					x						4. Hot Solder
(large)				x	x						5. Chemicals
				x	x						6. Scraping
Transformers				x	x			x	x	x	1. Brushing
(small)					x						2. Burning & Brushing
&					x			x			3. Hot Solder
Solenoids						x	x				4. Soldering Iron
(small)				x	x						5. Chemicals
				x	x						6. Scraping or Sanding

*Nylon = Nylenamel
EC = Enamel Cotton

*Celen = Celenamel
HF = Formvar

° HNC = Nylclad a Formvar-Nylon coated wire
PE = Plain Enameled Wire, Beldenamel

Hot Solder:—This method is well adapted in many applications for removing Nylclad or Formvar films with or without nylon or celanese textile covering. The leads are tinned and ready to solder after this operation. Sizes 21 to 30 AWG represent a range that is best adapted for this method. The high surface tension and temperature of the hot solder, the tendency for the solder to amalgamate and reduce the size or embrittle fine wire leads usually limits the usefulness of this method to the intermediate wire sizes shown.

A 50-50 lead-tin solder bath is used generally, at a temperature of approximately 500°C or higher. The tin percentage, after the bath has been used for sometime, will decrease. Tin additions must be made therefore from time to time as dictated by experience.

Some formulations of Formvar films are not uniformly removed by the hot solder method and erratic results sometimes are encountered. Formvar nylon combination coatings such as Nylclad can be removed consistently.

Brushing:—For large wire sizes with insulations such as cotton glass (with or without plain enamel, Formvar, Nylclad), Formvar, Nylclad, plain enamel, revolving steel wire brushes are in general use for stripping apparatus leads.

For finer film coated wire, glass fibre brushes are being increasingly used. In the case of fine wires, steel wire brushes tend to scratch the copper and embrittle the leads whereas glass fibre brushes remove the insulation with a burnishing action and have practically no injurious effect on the copper itself.

Burning:—Equipment has been developed and is being used especially for stripping wound motor armature leads that first removed the insulation by burning. Copper oxide thus formed is next removed by brushing.

Welding:—Lead wires and coil leads frequently are welded. A small high-temperature gas flame is applied to heat the spliced lead to a temperature that just melts the copper. This method is used extensively for medium and large motor stator coils. In this operation, of course, all the film coating and textile is burned off.

Chemicals:—There are many proprietary compounds in general use for stripping film-coated magnet wire. They have one property in common. All are evil smelling and injurious to the skin. Care must be exercised therefore in handling these materials, and for some the use of a ventilated enclosure or hood is mandatory.

Soldering iron and low-temperature solder pots:—Celenamel and nylon film-coated wires are in general use, particularly in the radio and television industry. Both materials being thermoplastic can be removed by using a rosin alcohol flux and the application of a soldering iron, or dipping in 650°F lead-tin solder.

Reprints of this table for shop use available on request.

Belden MAGNET WIRE

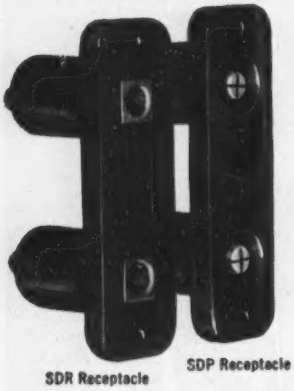
BELDEN MANUFACTURING CO.
4625 West Van Buren Street, Chicago 44, Illinois

Want more information? Use post card on last page.

CANNON PLUGS *for laboratory and switchboard*

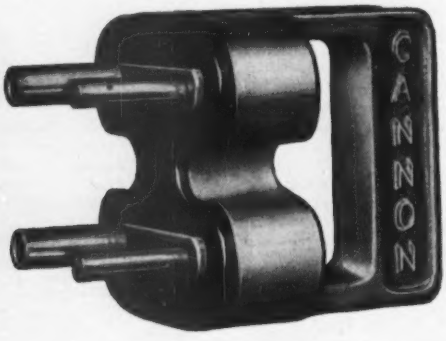
CSR Tandem Receptacle
CSP Plug

Here are a few examples of Cannon's Experimental Laboratory and Switchboard Connectors. They are used extensively throughout industry, public utilities, sound studios, broadcasting stations, college and university physics and chemistry laboratories, in AC network analyzers and electronic analog computers. They may be applied wherever quick disconnect switching



SDR Receptacle

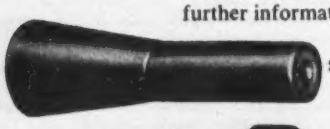
SDP Receptacle



SWPR-4 Switching Plug having both pin and socket contacts

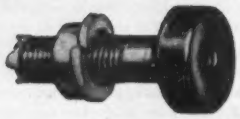
and patch cord plugs are required. High grade materials are used throughout. Molded phenolic of high dielectric strength is used for insulation. Both pin and socket contacts are machined from solid brass. Some are silver plated. All are rated at 75 amps. Pin contacts are split for low loss seating in tapered bore sockets. Single contact fittings are supplied in either red or black phenolic to designate direct or alternating current circuits respectively. Two-contact and larger plugs have sand-blasted cast aluminum shells and handles with clear lacquer finish. Various combinations of pin and socket contacts are used as a polarizing guide. For further information write for Bulletin LS5-1951.

SR Receptacle



SCR Plug

SCP Plug



SRB Receptacle

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. B-120, P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

around housing of an auto radio as it moves down the assembly line on a moving conveyor belt in Sylvania's Buffalo plant. Positions of the brackets are easily changed to accommodate a new housing design. Two brackets project inside the housing and one on the outside at the front edge to give rigid positioning.

The spool of solder is mounted on the bench directly under the left hand of the operator. This keeps the length of unrolled solder at a minimum and thereby prevents tangling. The solder holder is a piece of sheet metal that hooks over the metal front edge of the work bench. The stud for the spool is welded or bolted to the center of the projecting sheet.

Automatic Coil Dipper

A SPECIAL Crosley-designed automatic dipping machine applies a plastic protective coating to television receiver peaking coils at a production rate of 650 coils an hour. On the motor-driven face plate of the machine are six coil-holding arbors, each driven by gears inside the face plate.

The operator pushes the lead of a coil into the hole in the end of an

Automatic dipping machine set up for applying plastic coating to peaking coils. The same machine is also used for adding a plastic corona bead to flyback coils

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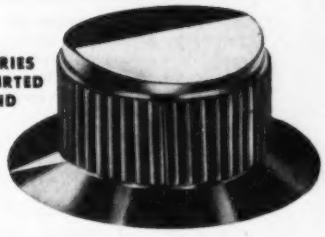

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So that you may specify them with confidence for the finest electronic and electrical equipment, Raytheon Standard Control Knobs must pass these quality control tests:

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SALT SPRAY — 50 hour fog test in accordance with Specification QQ-M-151.

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IMPACT — blows of 400, 800 and 1200 foot pounds through each of 3 axes in accordance with Specification 40T9.

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RAYTHEON STANDARD CONTROL KNOBS are made in five basic sizes and six functional styles of tough, durable "Tenite II" (cellulose acetate butyrate), injection molded with anodized aluminum inserts and dual setscrews. Black knobs available in "matte" or "mirror" finish.

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Based on Navy Drawing RE10F651A and styled to match our Standard Control Knob line. Available in two size ranges with symbol caps molded in the required colors.

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RAYTHEON PRODUCTS INCLUDE: WELDPOWER* welders; Voltage stabilizers (regulators); Transformers; Sonic oscillators for laboratory research; Standard control knobs; Electronic calculators and computers; Radio, television, subminiature and special purpose tubes; and other electronic equipment. *Reg. U. S. Pat. Off.

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NEW SYSTEM Accurately measures VSWR from 1.02 to 100/1

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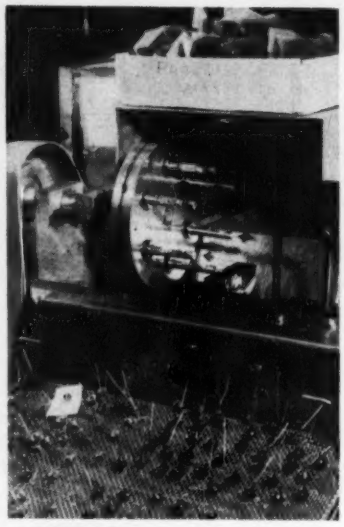


Machine with container of hot wax raised to dunking position. U-shaped metal bar comes up with pot, to serve as guard, because the wax is hot enough to burn fingers

arbor. A spring clip on the arbor holds the lead there. When the undipped coil reaches the lowest point on its orbital route, the operator pushes a foot pedal that controls an air-operated cylinder. This brings a pan of hot high-melting point wax up to the rotating coil. It is held there long enough for the coil to make several revolutions and get thoroughly coated with wax. Release of the foot pedal lowers the semicircular pan into the larger wax pot without splashing.

By the time that the dipped coil has completed its single revolution of travel around the face plate, the wax has cooled and hardened sufficiently to permit removal by the operator. Gloves are not needed. The completed coil is placed in a screen-type tray for further hardening, transporting and storage. A rack supports this tray directly in front of the operator.

The wax is heated by a Sta-Warm automatic electric heater having a range of 260 F to 550 F in seven steps.

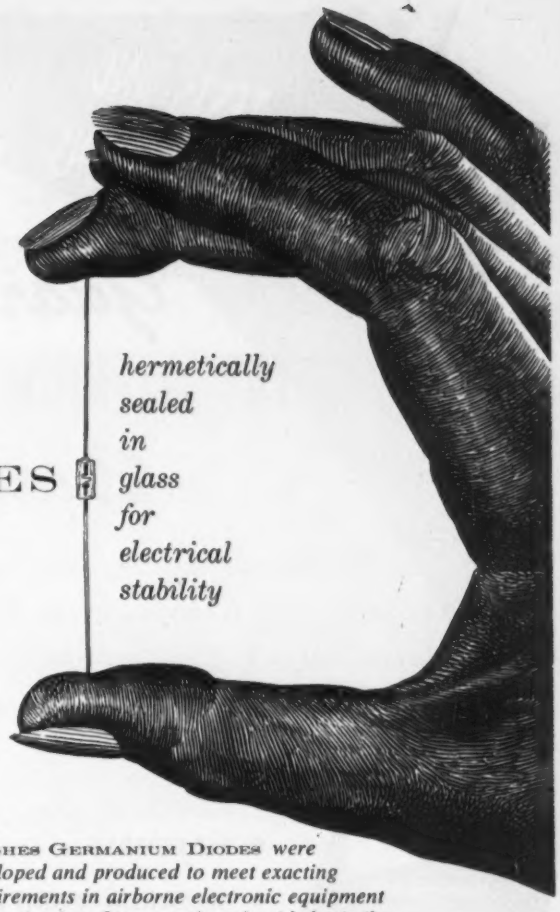
Masking Tape Holds Meters

WHEN RUNNING performance and life tests of experimental magnetic amplifiers, engineers at Bogue Electric use miniature multimeters

STABILITY SEALED IN

HUGHES

GERMANIUM DIODES



hermetically sealed in glass for electrical stability

HUGHES GERMANIUM DIODES *were developed and produced to meet exacting requirements in airborne electronic equipment for navigation, fire control, and guided missiles. In addition to the advantages of germanium diodes over vacuum tubes,* HUGHES GERMANIUM DIODES *exhibit these outstanding characteristics:*

1 **MOISTURE-PROOF**
Each hermetically sealed HUGHES DIODE is humidity cycled in saturated water vapor from +90°C. to −78°C., and then oscilloscope-tested for humidity penetration.

2 **DEPENDABLE**
Each HUGHES DIODE is subjected to JAN shock tests and then inspected under vibration for the familiar electrical instabilities—hysteresis, drift, and flutter. *Each* diode is aged and then reinspected for stability of electrical characteristics.

3 **THERMALLY STABLE**
The HUGHES DIODE is designed to reduce differential expansion which would cause instability of electrical characteristics with fluctuations in temperature. *Each* diode is temperature cycled and then tested to assure that the operating temperature range is limited only by inherent characteristics of germanium itself.

4 **SUBMINIATURIZED**
The HUGHES DIODE is designed for maximum space economy.

ELECTRICAL SPECIFICATIONS AT 25° C.

RTMA Type	Peak Inverse Voltage*	Minimum Forward Current at +1 volt—ma.	Maximum Back Current ma. (volts)
1N55B	190	5.0	0.5 (−150)
1N70A	130	3.0	0.01 (−10); 0.41 (−50)
1N67A	100	4.0	0.005 (−5); 0.05 (−50)
1N81A	50	3.0	0.01 (−10)
1N89	100	3.5	0.008 (−5); 0.1 (−50)
1N68A	130	3.0	0.625 (−100)
1N69A	75	5.0	0.05 (−10); 0.85 (−50)
1N90	60	3.0	0.8 (−50)

*NOTE: It has been found that Hughes Diodes will support 80% of this inverse voltage applied continuously at 25° C.

Because of expanded production capacity, HUGHES DIODES *are now available for commercial sale. Moderate quantities can be delivered from stock.* HUGHES DIODES *are classified in accordance with RTMA specifications, and also are supplied to special customer specifications, including high temperature electrical requirements.*

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more reasons why VICKERS makes a better rectifier:

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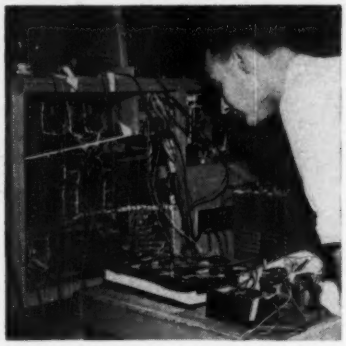
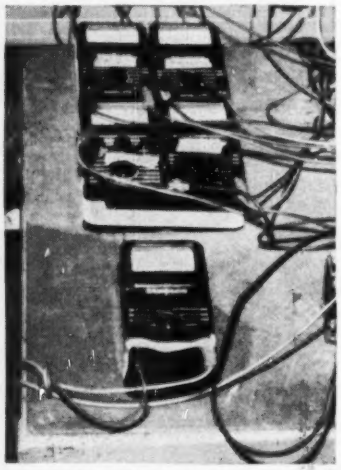


Magnetic amplifier test setup, showing use of masking tape for anchoring additional selenium rectifier on top of cabinet and for supporting glass thermometer

rather than individual voltmeters and ammeters for measuring circuit values. To minimize chances of having the multimeters pulled off the bench by their test leads, the instruments are grouped together with masking tape. The tape can readily be removed when the test is completed, for returning the individual meters to the stock room or rearranging them for other tests.

To avoid mistakes in reading meters, a piece of masking tape is placed on the face of each instrument and the characteristic being measured is lettered on the tape. These notes are in abbreviated forms; thus, SENSING identifies the Simpson multimeter which is set

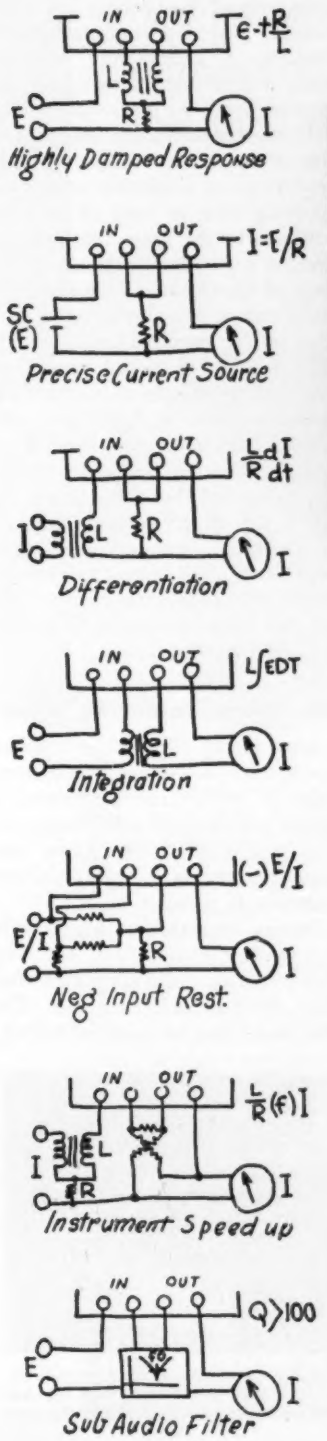


Use of masking tape to fasten four multimeters together temporarily, and method of using the tape to identify the function of each instrument. Tape across test lead plugs of lone multimeter in foreground is safety precaution when measuring 440-volt line voltage

Weston Model 1411

D-C INSTRUMENT AMPLIFIER

SPECIAL APPLICATION SCHEMATICS



- A rugged, stable D-C Amplifier, with less drift.
- Has permanent components—no electrolytic capacitors, no choppers.
- Uses only tube types on standard Preferred list.
- High response speed (in the order of 1/10 sec. nominal—faster on the higher ranges).
- Accuracy better than 0.1% on higher ranges . . . 1% general accuracy.
- For industrial applications, ranges down to 1 millivolt and 20 microamperes—for laboratory service, ranges down to 100 microvolts and 2 microamperes.
- Interchangeable plug-in range standards.
- Descriptive bulletin on request.

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"Surflene" is available in thirteen colors — red, orange, yellow, pink, light and dark green, blue gray, tan, brown, black, white and clear.

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Engineered Wire and Cable for the Electronic and Aircraft Industries

to a milliampere range for measuring the sensing current.

When a multimeter is used on a high-voltage range, such as 440 volts, masking tape is placed across the instrument ends of the test leads after they are plugged in. This strip of tape serves as a high-voltage warning and minimizes chances of accidentally or carelessly pulling out the test leads and thus exposing the high-voltage pins.

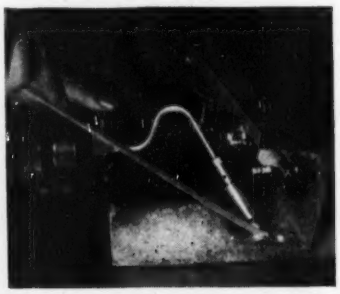
When measuring the temperature rise of selenium rectifiers during heat runs of magnetic amplifiers, masking tape is used to hold the bulb end of the glass thermometer against a rectifier plate. A longer strip of tape is used to support the other end of the thermometer in a position for easy reading.

During experimental work with magnetic amplifiers it is often necessary to hook in additional components temporarily. Instead of drilling holes in a chassis or cabinet for mounting these, the parts are set on top of the cabinet and held in position with masking tape. Leads with test clips can then be used for making connections, without risk that the part will fall off and dislodge all leads.

Aluminum Soldering Alloy

A NEW METAL alloy called Chemalloy facilities soldering to aluminum sheet or wire. The aluminum is merely heated beyond 800 F and the alloy rod rubbed on. After this tinning operation, conventional soft soldering is possible.

During shortages of copper wire in Crosley's radio plant, the new alloy was used to tin aluminum wire after cutting and stripping. The wire could then be soldered conven-



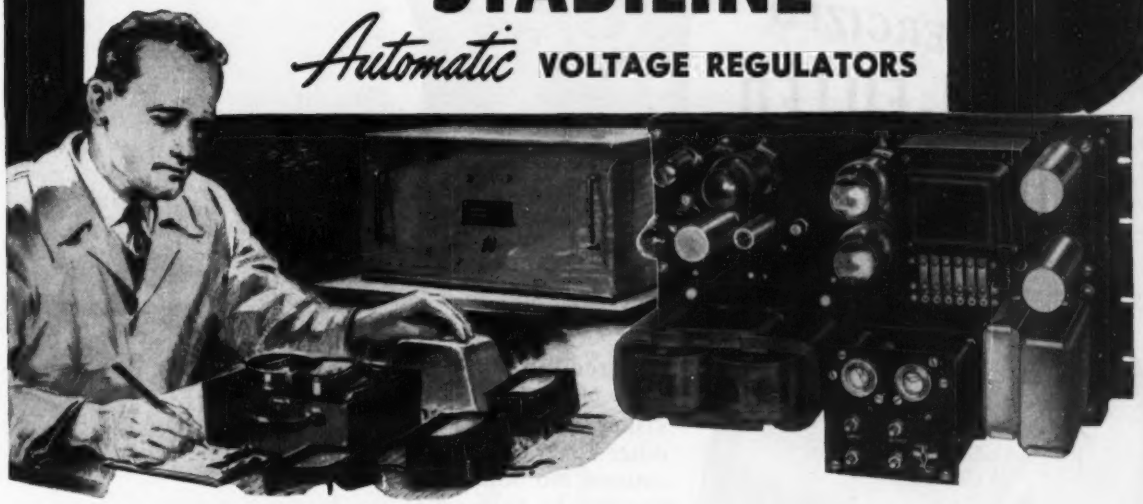
Tinning an aluminum radio chassis by heating with a gas torch and rubbing the heated area with a rod of the new alloy

sci'ence (si'ens), n.(OF., fr. L. scire (to know)

--and knowing the advantages of automatic voltage regulation, this man depends on

STABILINE

Automatic VOLTAGE REGULATORS



Scientific developments are based on EXACT knowledge. To obtain exact data in tests involving electrical circuitry, input voltages must remain constant. To insure dependable, accurate results . . . to eliminate the need for rerunning experiments because a change in input voltage has invalidated the first run . . . depend on a STABILINE Automatic Voltage Regulator to maintain constant voltage regardless of line or load changes.

Offering the finest in automatic voltage regulation equipment, The Superior Electric Company offers two types of STABILINE Automatic Voltage Regulators. Type IE (Instantaneous Electronic) is completely electronic with no moving parts. Correction — when compared with other types — may be considered instantaneous. Regulation and stabilization are excellent; maximum change in output voltage will not exceed ¼ of 1% for any or all variations in operating conditions. Waveform distortion never exceeds 3%.

Type EM (Electro Mechanical) is an electro-mechanical device with inherent characteristics of zero waveform distortion, high efficiency and faster correction than most types of automatic voltage regulators. It is ideal for controlling large industrial loads. Both types are available in numerous capacities and ratings.

SPECIAL MODELS of STABILINE Automatic Voltage Regulators can be supplied to meet individual requirements. Specializing exclusively in the design, development and manufacture of voltage control equipment, The Superior Electric Company is thoroughly experienced to help you in studying your exact needs and recommending the right equipment to serve you best.

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- VARICELL D-C POWER SUPPLIES

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ALPHA SOLDER

for everything electronic

CEN-TRI-CORE
ENERGIZED
ROSIN-FILLED
SOLDER

Guaranteed non-corrosive for radio, television, electronic and other electrical applications. No other solder works faster or easier . . . It provides greater fluxing uniformity and stronger smoother joints.

No activating chlorides or other chemical agents tending to produce acid conditions, toxic or sticky vapors, or latent corrosion.

Ideal where plated and/or oxidized parts must be soldered. Designed for use where faster fluxing is desirable.

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SOLDER

For those applications where a conventional rosin flux is required. For telephone and other critical soldering operations.

CEN-TRI-CORE's exclusive design guarantees rosin throughout the complete length of the wire. Eliminates rejects commonly encountered in the use of ordinary rosin core solders. CEN-TRI-CORE is faster fluxing: thinner walls between solder and rosin assure faster penetration of heat to the flux — requires less heat and guarantees maximum fluxing action of the rosin.

ALPHA *write for generous samples*
ALPHA METALS, INC.
58 Water Street, Jersey City 4, N. J.

tionally on the production lines.

In Lear's radio plant, ingots of the alloy were melted in large solder pots, and aluminum cans inserted therein to facilitate making hermetic seals. A similar setup was used by the Navy to coat aluminum transducers so they could be immersed in sea water.

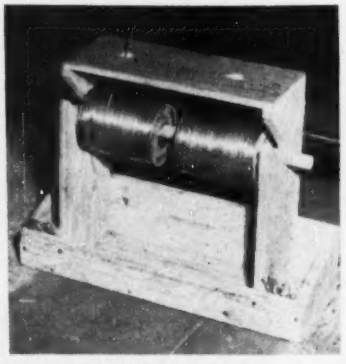
At the melting point of the alloy, it acts as a simple solder. Above the melting point, the action is that of welding, and capillary action starts under the skin of the parent metal. This spreading of the alloy in every direction away from concentrated heat makes it ideal for use on thin-gage aluminum or screen wire that would normally disintegrate or burn through.

The alloy was developed by Chemally Associates, Santee, California, while seeking an improved method of fabricating aluminum waveguides and attaching flanges. Even where one sheet of aluminum stands on edge against the full surface of another sheet, a weld made with the alloy and a small propane gas torch is sufficiently strong that the aluminum breaks before the weld.

Two-Spool Solder Holder

A PORTABLE on-the-floor holder for spools of solder gives flexibility for rearranging soldering positions on an assembly line, provides storage space for discarded and newly cleaned soldering iron tips, and makes a supply of solder last twice as long before replenishing from the stock room.

The holders are constructed from



Simple holder for two spools of solder. Compartments at ends hold soldering iron tips

For copper in any form – For top-notch service – Call Chase

CHASE

What kind of copper or copper alloy do you need? Free-cutting brass rod? Sheet and strip brass? Phosphor bronze for springs? Call your nearby Chase warehouse. We can supply you, subject to government controls, with the widest variety of brass or copper materials for production, maintenance or repair.

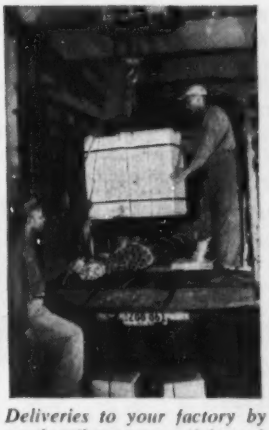
Many of our branches are equipped to slit, saw, or shear our metals or your own stocks to specifications.

Chase® BRASS & COPPER

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

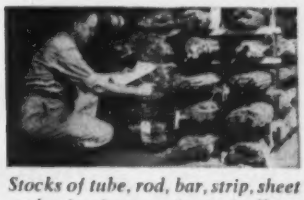
• *The Nation's Headquarters for Brass & Copper*

Albany†	Cincinnati	Houston†	Minneapolis	Pittsburgh	Seattle
Atlanta	Cleveland	Indianapolis	Newark	Providence	Waterbury
Baltimore	Dallas	Kansas City, Mo.	New Orleans	Rochester†	
Boston	Denver†	Los Angeles	New York	St. Louis	(†sales office
Chicago	Detroit	Milwaukee	Philadelphia	San Francisco	only)

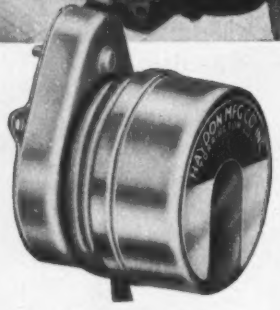


Deliveries to your factory by truck, rail or express, if desired.

Close tolerance sawing, slitting, shearing to your specifications.



Stocks of tube, rod, bar, strip, sheet and wire in a variety of alloys.



400 Cycle Motor

SYNCHRONOUS TIMING MOTORS and TIMERS for

- *Industrial*
- *Military*
- *Commercial Uses*

HAYDON* research and engineering staffs constantly seek to develop new and build better products. One example is the HAYDON 400 cycle timing motor. This is an hysteresis type synchronous timing motor, for use as a separate motor or in many different types of timers. HAYDON personnel and plant are equipped to build motors and timers using D.C., 60 cycle or 400 cycle for military or civilian applications.

HAYDON manufactures a wide range of dependable timing motors notable for their small size; quiet operation; total enclosure; separate systems for controlled lubrication of rotor and gear train; ability to operate in any position. Standard speed range from 60 rpm to one revolution in 7 days. The HAYDON motor is the basic element for standard timing components and custom-engineered timers designed and manufactured by the company for volume applications.

DESIGN INFORMATION

HAYDON will gladly send you technical data on request.

*TRADEMARK REG. U. S. PAT. OFFICE

HAYDON Manufacturing Co., Inc.

Subsidiary of GENERAL TIME CORPORATION

2426 ELM STREET

TORRINGTON CONNECTICUT

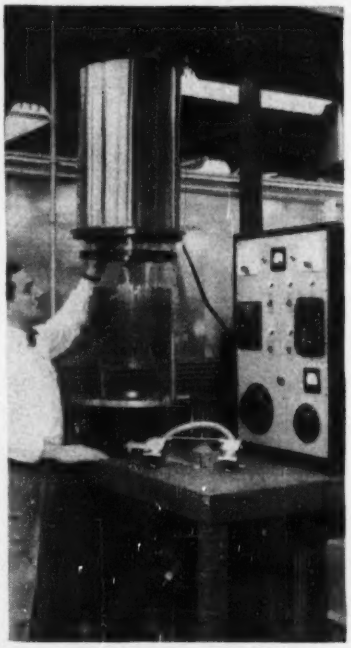
plywood and assembled entirely with box nails, hence can be built at minimum cost. Slots are cut in the uprights for a half-inch hardwood dowel rod that serves as a shaft for the two spools of solder. This holder is used in the plant of Olympic Radio & Television.

Vacuum Bakeout Ovens

THOROUGH CLEANING of precision parts for mass spectrometers is achieved with a carefully planned sequence of cleaning operations associated with a 2,500-watt oven providing vacuum bakeout, in a Pasadena plant of Consolidated Engineering Corp.

The oven is mounted directly over the vacuum pump, with its controls on an adjacent table. The Pyrex bell jar and the metal shield surrounding the insulation are counterbalanced for ease in lifting. Nichrome ribbon is wound around the outside of the bell jar to serve as the heating element for the oven.

Preliminary cleaning of the parts before vacuum bakeout is accomplished by washing in Dreft deter-



Bakeout equipment with bell jar and oven lifted to show basket in which parts are placed for final degasification. Large part on bench is an analyzer tube for a mass spectrometer, one of the largest parts customarily baked out

Short cut to loss . . . . . .

8:30 on a hectic night — and bids for the Cohansey Run Bridge had to be in the night's mail. It was after 5 when the estimators finished the roughs — everything was supposed to be automatic from that point on. Miss Exton was at the new electric calculating machine literally steaming along — when suddenly it stopped. Seems it wasn't steam — it was smoke — the machine had shorted through failure of the electrical insulation. Too late to get a serviceman — and it took 'til 4 A.M. to finish the calculations by hand — all because some manufacturer tried to save pennies by using an electrical insulation that cracked.

Electrical equipment is wonderful when it works. But let the insulation short out and failure is complete.

BH "649", pioneer in the field of vinyl-coated fiberglas tubings, provides extra protection for your equipment against costly rejections and failures. It is permanently flexible, and offers high dielectric strength at continuous operating temperatures of 110°C., with "spot" resistance up to 220°C., without regard to aging and abuse.

Made of continuous Fiberglas yarns, coated with a vinyl compound, BH "649" can be twisted and knotted without damage. It withstands "push-back" during installation, without loss of physical or dielectric properties. It will not fail on a bend — even when bent back upon itself. It is absolutely fray and ravel proof. An imposing list of users testifies to its superiority — specific applications cited on request.

BH "649" is one of a family of BH electrical insulations, each designed to meet particular conditions in service. Give us a few facts about your requirements, product, operating temperatures, voltages. We will furnish production samples for testing purposes.

Address Dept. E-2

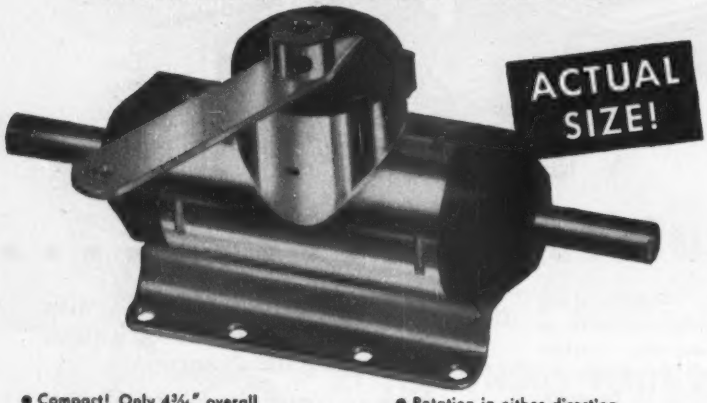
Bentley, Harris Manufacturing Co.
Conshohocken, Pa.

BH *Fiberglas** SLEEVINGS

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U. S. Pat. No. 2393530). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

Metron MINIATURE SPEED CHANGERS

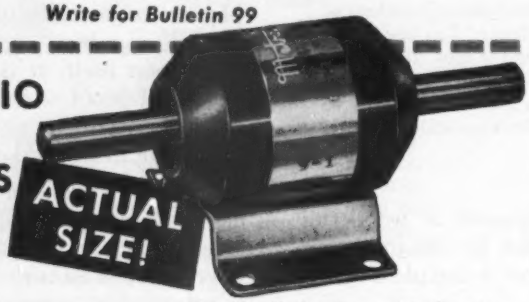
VARIABLE SPEED DRIVES



- Compact! Only 4 3/16" overall
- Light! Weigh only 5½ oz.
- Continuously variable speeds over a wide range
- Knob, lever, push-rod or gear control (Lever control illustrated)
- Rotation in either direction
- Coaxial shafts for in-line construction
- Ball-bearings throughout
- Completely sealed
- Permanently lubricated for trouble-free high/low temperature service
- Operate in any position

Write for Bulletin 99

FIXED RATIO SPEED CHANGERS (Gear Type)



- Only 1.050" diameter!
- Single section weighs only 3 oz.
- STANDARD ratios from 10:9 to 531,441:11
- Hobbed gears for smooth, precision running
- Anti-backlash units . . . virtually zero backlash in either direction
- Completely sealed
- Permanently lubricated
- Mount in any position

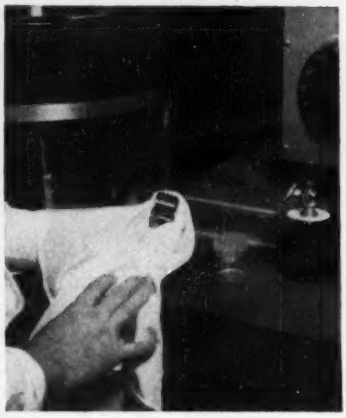
Write for Bulletin 100

MINIATURE COMBINATION FIXED AND VARIABLE SPEED CHANGERS

For applications requiring variable speed at a reduced nominal output speed, combinations of Metron Variable Speed Drives and Fixed Ratio Speed Changers are available in compact, integral units. Ask for Technical Data, or write giving your requirements for prompt engineering recommendations and prices.

METRON INSTRUMENT COMPANY
440 Lincoln Street • Denver 9, Colorado

BUILT BY Metron MAKERS OF INSTRUMENTS FOR PRECISION MEASUREMENT



Method of handling baked-out parts with a lint-free cloth. Glass container is used for storage before baking, and container at right is used after bake out

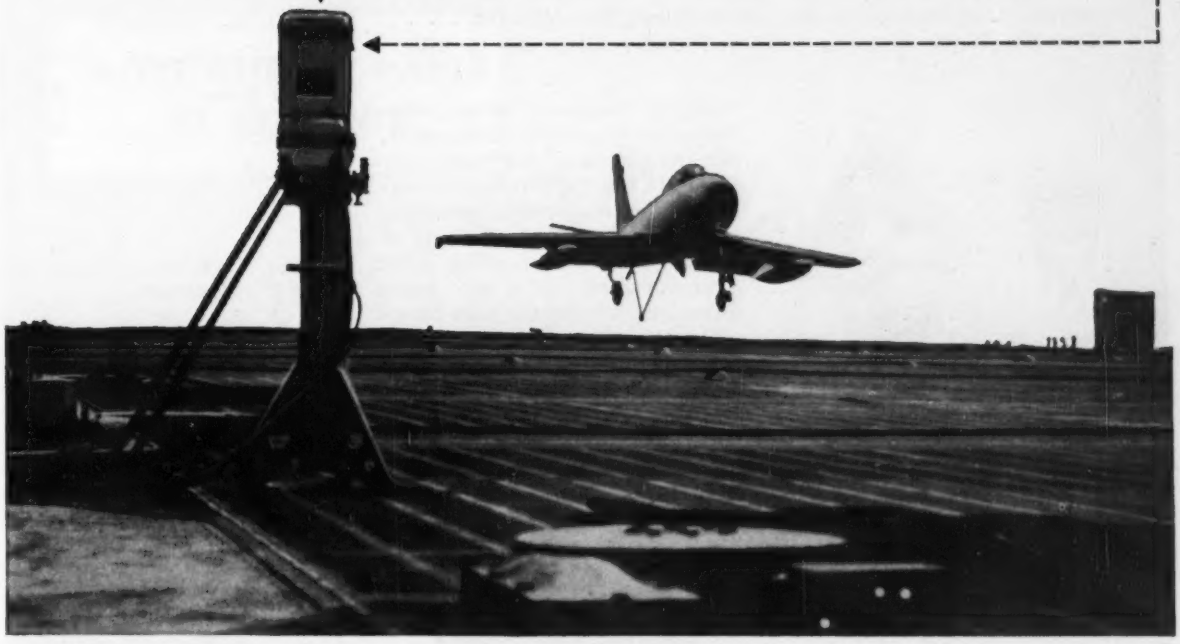
gent and warm water, followed by a series of rinses in tap water, distilled water, alcohol, benzine and ether, and drying under a heat lamp. After the dunking in Dreft, the parts are handled with clean tweezers to prevent further contamination.

After this cleaning, the parts are placed in the work basket inside the bell jar. Small parts may be placed around larger parts to utilize the full capacity of the basket. Pressure in the bakeout oven is approximately 2×10^{-6} mm Hg, and temperature of baking is about 400 C. A typical baking cycle requires three hours, with the exact time depending upon the load in the oven. The gasses driven off from the surfaces and the microscopic pores and fissures of the parts include nitrogen, oxygen, hydrogen, carbon dioxide and carbon monoxide.

Without the bakeout procedure, parts installed in highly sensitive mass spectrometers and mass spectrometer-type leak detectors would require a lengthy period of bakeout after assembly in the machine.

When parts are to be stored between cleaning and bakeout, they are placed in stoppered glass containers. For storage and shipment after bakeout, the parts are placed in special metal containers that can be evacuated and filled with helium to prevent corrosion or contamination. Baked-out parts are handled only through special lint-free cloths.

BRIGHT MINDS CONJURE UP ELECTRONIC MENTAL GIANTS



AT NORTH AMERICAN AVIATION

An airplane's rate of descent used to be painstakingly computed from photographs which took several days to evaluate. Then North American's electro-mechanical engineers developed TRODI (above) for the Navy for carrier suitability tests.

TRODI is an electro-optical Touchdown Rate of Descent Indicator that watches the airplane descend, measures its rate, and electronically readies its information so it's available the minute the pilot lands. TRODI's electronic brain saves untold time, men and money for the Navy.

TRODI is just one ingenious example of the challenging electronic and electro-mechanical work being pioneered at North American by some of the nation's best scientific minds, using the most advanced facilities.

If you like theory, you may find an exciting and secure future at North American in the field of operations analysis, advanced dynamics, kinematics, noise, error or information theory, systems engineering, statistical quality control or servo analysis.

If research and development are your specialty, you'll find attractive opportunities in radar and communications systems, analogue and digital computers, automatic guidance systems or optics.

Write today, including a summary of your education and experience, to:

NORTH AMERICAN AVIATION, INC.

Engineering Personnel, Missile and Control Equipment Department

12214 Lakewood Boulevard, Dept. 93-E, Downey, California

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Recently Developed Test Instruments, New Materials and Components and Several of the Latest Tubes Are Included . . . Forty-Six Trade Bulletins Reviewed Under *Literature* (p 328)

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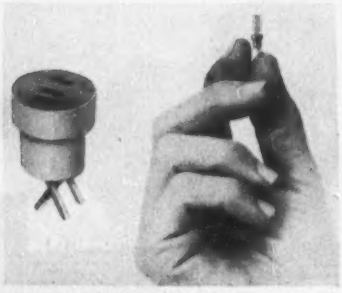
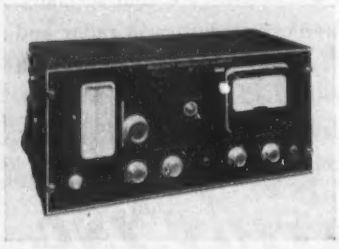


Transistor Sockets

MYCALEX TUBE SOCKET CORP., 60 Clifton Blvd., Clifton, N. J. The body of these transistor sockets is precision-molded of Mycalex 410, glass-bonded mica insulation for lasting dimensional stability, low dielectric loss, immunity to high temperature and humidity exposure combined with maximum mechanical strength. The loss factor is only 0.014 at 1 mc and dielectric strength is 400 v per mil. Contacts can be supplied in brass or beryllium copper. The sockets are readily solderable. Socket bodies will not warp or crack when subjected to high soldering temperatures. They function in ambient temperatures to 700 F.



F-M Monitor

BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass., announces the MD-33 frequency-modulation monitor designed to check the modulation swing of f-m transmitters operating in the police, fire and special service bands from 25 to 174 mc. This continuous coverage is accomplished in two bands without the use of plug-in units of any kind. Modulation swing is indicated directly on a 4-in. panel meter with a 20-kc full scale linear calibration. A dual range flasher circuit permits checking overmodulation by the shortest of voice peaks at either of two preset amounts of swing. The unit is 9 in. high x 20½ in. wide x 12 in. deep. Weight is 35 lb.

Miniature Power Supply

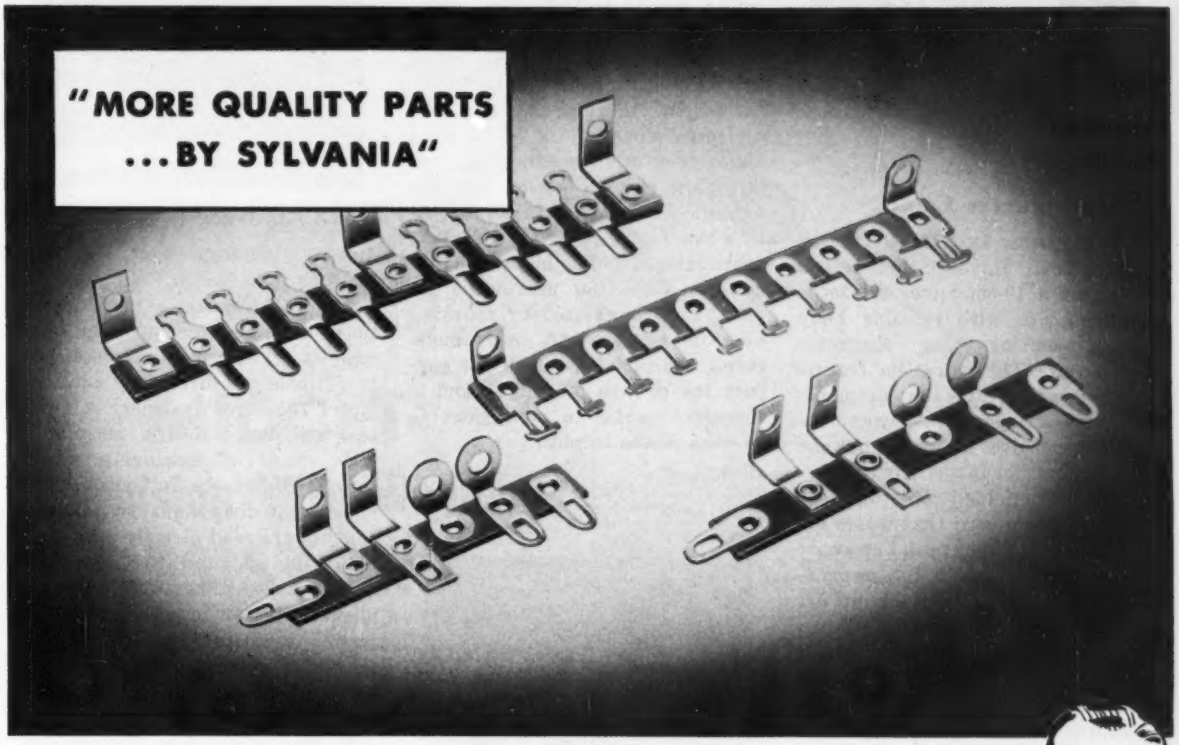
AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md., has released model A-1220, the first of a series of miniaturized d-c to d-c power supplies using a 450-cycle vibrator. Total weight is only 1 lb. 14 oz. Vibrator and power supply are hermetically sealed. The vibrator attaches with snap fasteners. Output is 150 v at 100 ma; peak ripple, 1.0 percent. Three standard units of 6, 12 and 26.5 v d-c input are offered. On special order output power up to 20 w, output voltages up to 300 v, and input voltage between 4 and 110 v d-c can be furnished. The unit is designed to meet severe military standards of vibration, shock, temperature range, humidity and altitude.

Tiny Transmitter

MOTOROLA, INC., 4545 W. Augusta Blvd., Chicago 51, Ill., has announced mass production of a hand sized Handie Micro-Talkie transmitter designed to operate in the 152 to 174-mc frequency bands. The compact unit, weighing only 1 lb 13 oz, has a power output of 20 to 40 mw and a tested optimum range up to 5 miles. Overall case dimensions are only 7⅜ in. x 2½ in. x 1¾ in. A rigid, chrome plated loop antenna doubles as the carrying handle. The unit uses 8 subminiature tube stages with printed associated circuitry. With the transmitter operated on the practical duty cycle of 15 seconds out of each 5 minutes, A battery life is one work week with the B batteries lasting 2½ weeks. The unit is especially useful for patrolmen on foot, firemen at the scene of a fire, or for on-the-spot news reporting. Indus-

MAKE BETTER CONNECTIONS

with Sylvania's improved terminal strips



Sylvania now offers you a wide variety of highest quality terminal strips . . . equipped with from 2 to 14 lugs . . . suitable for many different applications.

Insulators are made from laminated phenolic. Contacts are brass or cadmium-plated steel. Sylvania Terminal Strips can be supplied to your specifications.

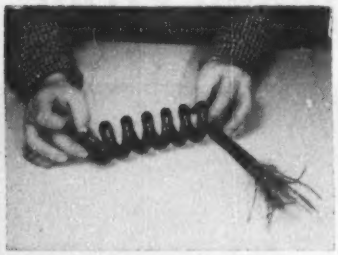
Today, with enlarged, modern plastic molding equipment and metal stamping facilities, Sylvania offers you precision-built components of highest quality at lowest possible cost. For new illustrated catalog showing the long line of Sylvania Terminal Strips and other radio and electronics components now available, write to: Sylvania Electric Products Inc., Dept. 3A-1002, 1740 Broadway, N. Y. 19, N. Y

SEND FOR THIS CATALOG

SYLVANIA

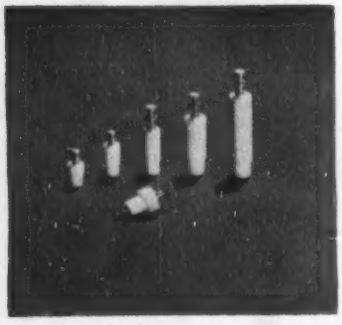
RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

trial uses include railroad car checking, inventory control and materials handling.



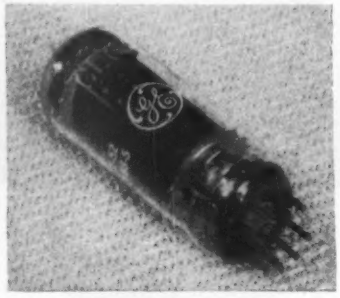
Multiconductor Cable

KOILED KORDS, INC., 1565 Dixwell Ave., New Haven, Conn., has developed a 19-conductor retractile cord for use with movable relay rack mountings for electronic equipment. The retractile feature of the cord permits the equipment to remain operative when the mounting shelves are pulled out and then rotated for inspection or servicing. This shielded cable answers the need for a cord that would extend to the desired length but would not become fouled in the mechanism when relaxed. Conductors are No. 23 AWG tinned Hi-Tenso bronze insulated with synthetic rubber. A wound shield of tinsel is applied over the core of seven conductors. The remaining 12 conductors are cabled about this core and covered with another tinsel shield and an overall rubber jacket to an outside diameter of 0.540 in. The cord is then vulcanized in the coiled shape and terminated as required.



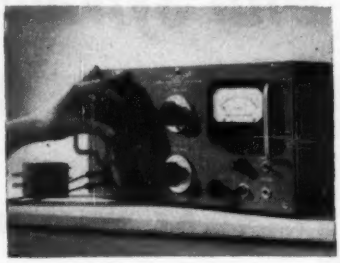
Insulated Terminals

SEALECTRO CORP., 186 Union Ave., New Rochelle, N. Y., has introduced a line of DuPont Teflon insulated standoff and feed-through terminals. These Press-Fit terminals are one complete unit ready for assembly, eliminating the use of any and all hardware for installation. A simple press fit with an inexpensive hand tool or drill press, into a chassis drilled with a predetermined diameter hole fastens the terminal securely. Teflon's excellent electrical properties are unaffected by thermal change. Its dielectric constant is lower than almost any other engineering material and in combination with the extremely low power factor results in a loss factor lower than for any other material. The losses are also constant into the microwave region. It is unaffected by sparking over its surface and sheds moisture. Additionally, it will not support the growth of fungus and is therefore useful in equipment to be used in the tropics.



Power Pentode

GENERAL ELECTRIC CO., Schenectady, N. Y., has announced type 6CL6 power pentode for use in the video output stage of television receivers. Using this tube it is possible to obtain a voltage gain of from 40 to 45 in wide band video circuits. The tube features high transconductance, low capacitances and high output current capability. It provides a high plate current at low plate voltages and can supply enough peak-to-peak output voltage to drive large picture tubes with high efficiency and low amplitude distortion. It is capable of supplying 132 v peak-to-peak output across a load resistor of 3,900 ohms. In addition to its use in video output service, the new 9-pin miniature may also be used as a wide-band amplifier in industrial and laboratory equipment.

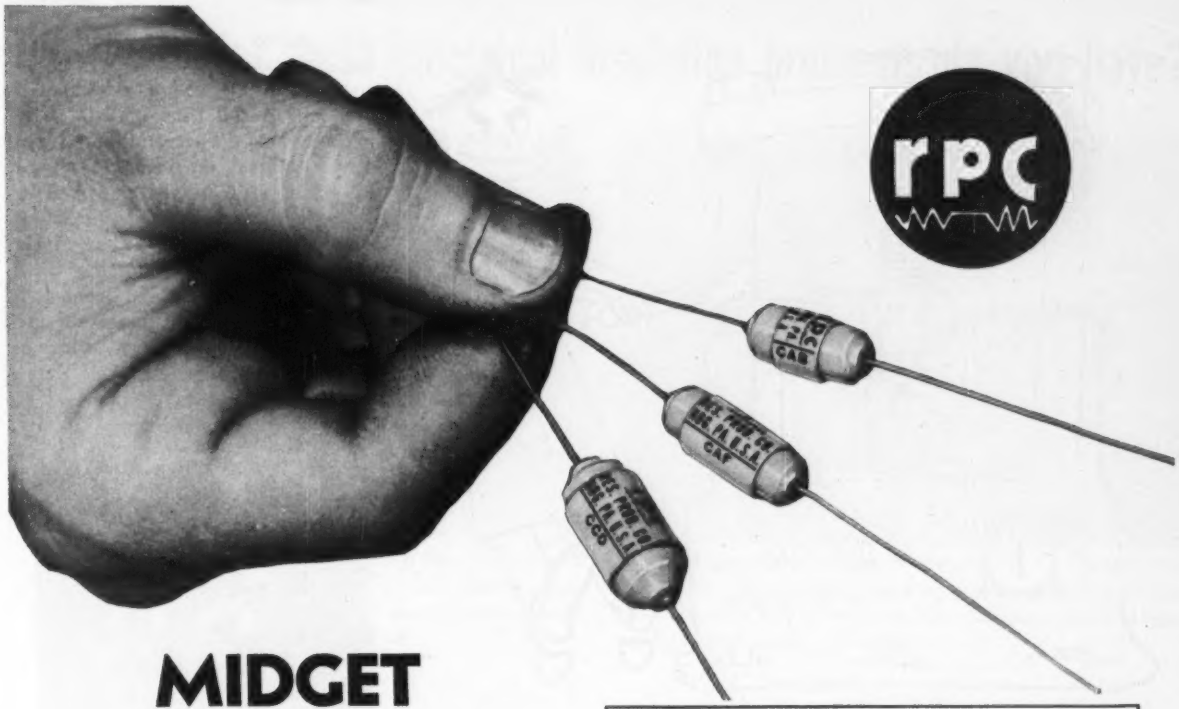


Wave Analyzer

SIERRA ELECTRONIC CORP., 810 Brittan Ave., San Carlos, Calif. Analysis of the frequencies and amplitudes of signal components in a complex waveform is accomplished in a simple and direct way with the model 121 wave analyzer. A novel two attenuator design permits a wide range of measuring amplitudes without the introduction of instrument distortion. Signal components are read directly on a 4-in. indicating instrument calibrated in db. Voltage calibration is accomplished with an internal 100-kc injection oscillator, and a listening jack is provided for monitoring the signal being measured. The instrument has an input level range from +42 dbm to −70 dbm at a 600-ohm impedance level. Input impedance is 10,000 ohms in the pass band. Selectivity is such that 100 cps off resonance the response is 3 db down; 200 cps off resonance, 10 db down; 500 cps, 30 db; and 1,000 cps, 45 db. Measuring accuracy is ±2 db and spurious components are at least 50 db below signal fundamental.

High Speed Trigger

THE WALKIRT CO., 145 W. Hazel St., Inglewood, Calif., announces the type M1563 high speed trigger. It is a Schmitt type circuit designed to meet the wide need for a fast pulse suitable for driving many types of counting or scaling equipment from a sine wave input. The unit can also be driven from a square wave input, in which case it acts as an amplifier and will pro-



MIDGET
Precision Wire Wound
RESISTORS

TYPE	DIMENSIONS		Jan-R-93	POWER RATING (WATTS)		RESISTANCE	
	Leng.	Diam.		Jan.	Comm'l.	Min. (ohms)	Max. (meg.)
CAB	1/2	9/32	———	——	1/4	2.0	0.15
CAF	3/4	9/32	RB51B	1/4	1/2	1.0	0.40
CCD	3/4	3/8	RB51B	1/4	1/2	0.5	1.0

Successfully used in Armed Forces' most critical applications

Scores of results have established the superiority and outstanding quality of RPC's new TYPE C PRECISION WIRE WOUND RESISTORS. These high quality units are designed to meet the stringent requirements of JAN-R-93.

Completely insulated precision resistors which may be soldered directly into circuits. Their small size and light weight make them self supporting. Ideal for aircraft applications where reduction in size and weight are vital.

Completely enclosed in rugged plastic of high insulation value. Windings are impregnated in special compound and protected against dust, salt spray, humidity and mechanical damage.

Winding form is of low loss steatite having extremely high insulating quality with low coefficient of expansion. Impervious to moisture.

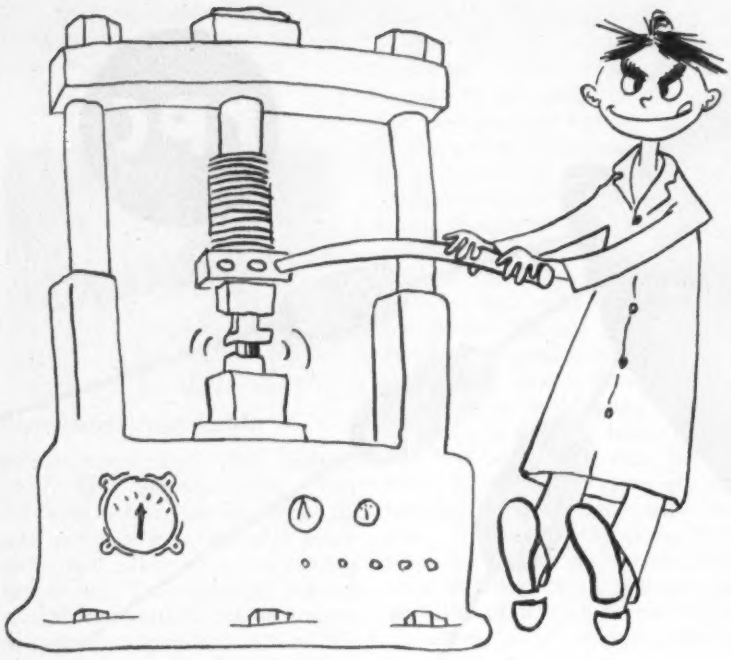
Type C resistors are wound with specially tested low temperature coefficient alloys. RPC's Type C resistors are being used by many of America's outstanding manufacturers. They are available in any amount with prompt delivery. Write for complete information.

RESISTANCE PRODUCTS CO.

714 RACE ST. HARRISBURG, PENNA.

SPECIALIZING IN THE MANUFACTURE OF QUALITY RESISTORS IN ANY AMOUNT

HIGH MEGOHM, HIGH VOLTAGE, HIGH FREQUENCY, WIRE WOUND PRECISION



SQUEEZING THE MOST OUT OF SENSITIVE RELAYS

New procedure developed by Prime Contractors accomplishes up-grading of general specifications—of real benefit to all concerned.

1. *Select a collection of irrelevant MIL specs. (preferably obsolete).*
2. *Using $K = 1.63\ Q^N$, raise all known numerical considerations.*
3. *From the Sigma Catalog, select the characteristics of at least three relays. Divide all numbers by $13.6r^2$.*
4. *Apply these characteristics to the smallest and cheapest relay and prepare the spec. accordingly.*
5. *Type in Ipsilanti on 36" x 48" drawing.*
6. *Your Purchasing Department will do the rest.*
7. *Any resemblance between the product and the drawing is purely coincidental.*
8. *There is a possibility that the relay will do the job.*
9. *Seriously, shouting at our application engineers gets you nowhere. They are paid to be helpful and courteous, but they are not yes-men.*

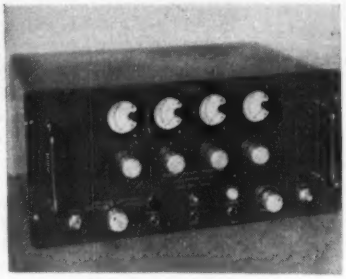
A realistic set of requirements can usually be met even by Sigma Relays, and the aforesaid engineers can often suggest circuit modifications to better suit existing standards and components.

SIGMA

SIGMA INSTRUMENTS, INC.

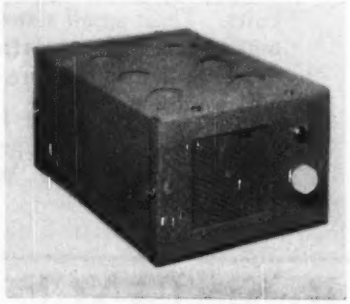
62 PEARL ST., SO. BRAINTREE, BOSTON 85, MASS.

duce pulses of either positive or negative polarity. The 150-v peak-to-peak output has a rise of 0.2 μsec and a fall time of 0.45 μsec, measured to 90-percent amplitude. Nominal plate to ground voltage on the type 5670 tube employed is 100 v when conducting, and 250 v when nonconducting. The type 5670 tube is used meeting new military reliable tube requirements. The unit is packaged in a resin encapsulated plug-in form with a versatile 11-prong octal-style base.



Digital Preset Counter

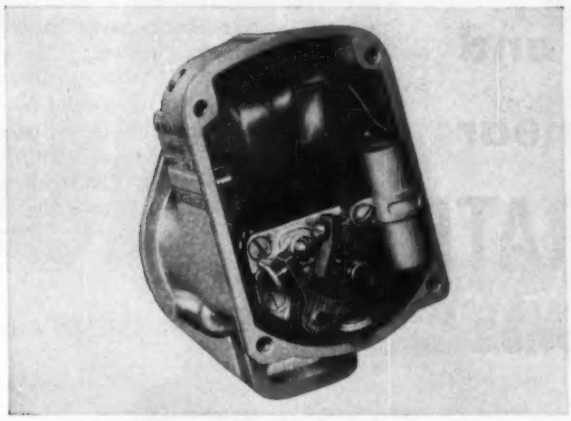
DIGITAL INSTRUMENT CO., INC., P. O. Box 1246, Coral Gables, Florida, has introduced two high-speed presetting types of counters. In the model 333 any number may be set from 0 to 999 and in model 334, any number from 0 to 9,999. Recycling can be obtained at speeds as high as 20,000 per second and the counter will operate as a standard counter at speeds up to 100,000 counts per second. Relay contacts are available for control functions. Direct-coupled output is available for electronic control and gating.



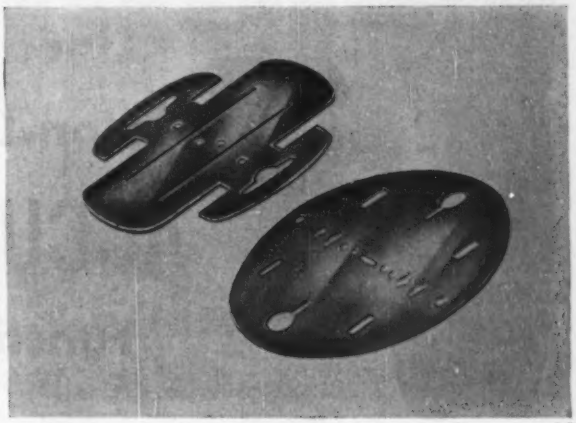
Mobile Wireless Receiver

RADIO APPARATUS CORP., Indianapolis, Ind., now has available the

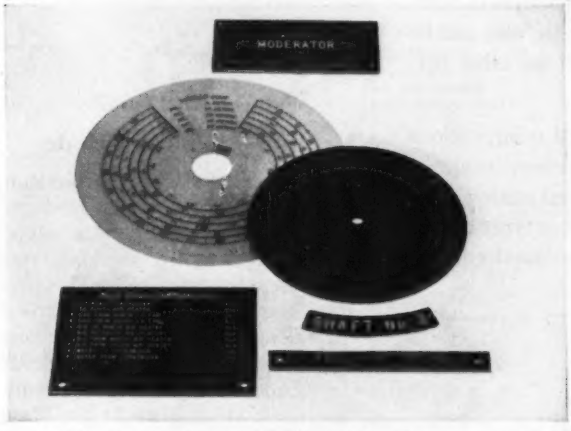
How many of these electrical insulation problems do you have?



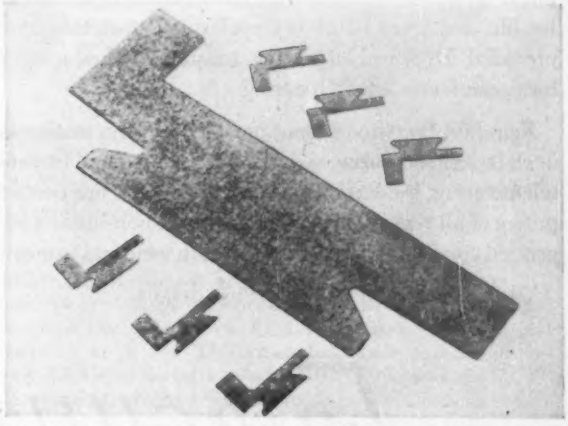
1. Looking for an efficient coil wrapping for small spaces? EMPIRE® varnished bias-cut nylon tape is highly flexible, strong and efficient . . . makes a thin insulation of unusually high dielectric strength with good resistance to oil and water.



2. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO.



3. Looking for a better material for wiring diagrams, controls, instruments, dials and nameplates? DECORATIVE LAMICOID® resists wear, aging, weathering, oils, corrosive vapors, moisture and temperature extremes. Won't warp, check or chip. Good electrical properties. Wipes clean with a damp cloth.



4. Need a class H segment plate that's easy to work with? ISOMICA* Segment Plate — made of built-up continuous mica sheet — shows no tendency to split or flake. Small segments of heavy thickness may be punched, and larger segments can be accurately sawed, milled, punched, etc.

Whatever electrical insulation material you need — standard or special — class A to class H — MICO makes it best. We manufacture it, cut it to size, or fabricate it to your specification. Send us your blueprints or problems today.

*Trade-mark

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MICA Insulator COMPANY

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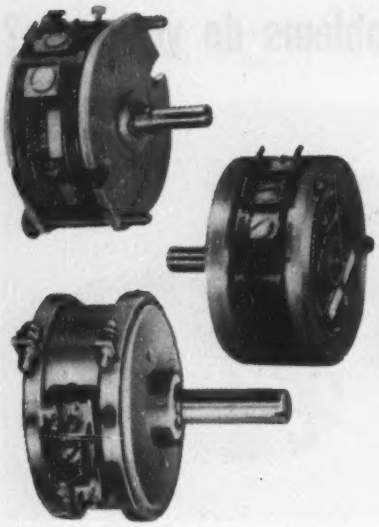


Need Linear and Non-Linear ACCURATE Functions?

Use Fairchild Precision Potentiometers

Experience with Fairchild potentiometers in hundreds of applications shows that these units are unusually precise. Accuracies of ±1% in non-linear types and as high as ±0.05% in linear types can be guaranteed. Service life as high as 10,000,000 cycles, under certain conditions, also can be provided. High resolution, low torque, and low noise level are other performance features worth noting.

Fairchild Precision Potentiometers perform mathematical computations in electrical computing systems for machine-tool controls, process controls, telemetering, guided missiles, flight control, fire control, and analog computers of all types. They are available in non-linear and linear types and in ganged combinations of either or both windings to meet your requirements.

Use the coupon below to get full details.

FAIRCHILD
PRECISION POTENTIOMETERS

THIS COUPON MAY HELP SOLVE YOUR POTENTIOMETER PROBLEMS!

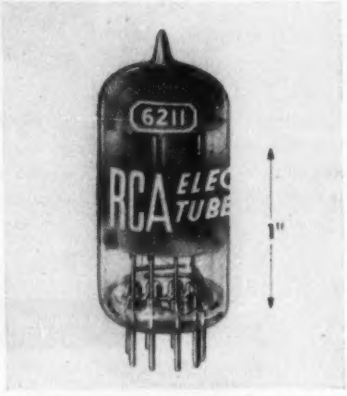
Department 140-32A1
Potentiometer Division
Fairchild Camera and Instrument Corporation
Hicksville, Long Island, New York

Gentlemen:

Please send me complete information about Fairchild Precision Potentiometers, and tell me how you might solve my potentiometer problems.

Name_____
Title_____
Company_____
Address_____

Monitoradio Pager—model AmC-1—which is a radio paging receiver for use in motor cars as a supplement to the pocket receiver utilized by most paging systems. Thoroughly field tested in conjunction with one of the paging systems now in operation, this unit is the only demonstrated receiver available for this type of operation. The receiver is expected to be used in many fields within a short time.



Medium-Mu Twin Triode

RADIO CORP. OF AMERICA, Harrison, N. J. The 6211 is a new medium-mu twin triode of the 9-pin miniature type designed especially for frequency-divider circuits in electronic computers and other on-off control applications involving long periods of operation under cutoff conditions. It has separate terminals for each cathode to facilitate flexibility of circuit arrangement, and a midtapped heater to permit operation from either a 6.3-v or 12.6-v supply. The heater is made of pure tungsten to give long life under conditions of frequent on-off switching.

Transformer Cans

TRIAD TRANSFORMER MFG. CO., 4055 Redwood Ave., Venice, Calif., announces the introduction of a line of deep drawn transformer cans. These cans are seamless and are drawn from cold rolled steel to meet the dimensional specifications of MIL-T-27. The lids are internal and require no stops since they fit the can snugly. Cans are available only

SAVE POWER

...with RCA *thoriated-tungsten filament* tubes

RCA-5770
SAVE—60% filament power, over comparable pure-tungsten type
RCA-5671
SAVE—60% filament power, over comparable pure-tungsten type
RCA-5762
SAVE—Filament power, only 365 w. (No comparable pure-tungsten type)
RCA-5771
SAVE—70% filament power, over comparable pure-tungsten type

Designed specifically for industrial, communication, and broadcast services, these high-power tubes can save hundreds of dollars a year in filament power—can cut initial equipment power costs substantially.

For instance • RCA-5770 takes 150-kw input up to 20 Mc, yet this triode requires only 3.1 kw of filament power—*saves 60% over the comparable pure-tungsten-filament type* • RCA-5671 takes 100-kw input up to 10 Mc. This air-cooled triode requires only 3.1 kw of filament power—*saves 60% over the comparable pure-tungsten-filament type* • RCA-5771 takes 60-kw up to 25 Mc. This triode requires only 1275 watts of filament power—*saves 70% over the pure-tungsten-filament type* • RCA-5762 takes 5.5-kw input up to 110 Mc. This VHF triode *takes only 365 watts of filament power!*

Consider these important features for the equipment you design. For additional technical information write RCA, Commercial Engineering, Section 42BR, Harrison, New Jersey. For application assistance, simply call your nearest RCA Field Office:

(EAST) Humboldt 5-3900, 415 S. 5th St., Harrison, N. J.
(MIDWEST) Whitehall 4-2900, 589 E. Illinois St., Chicago, Ill.
(WEST) Madison 9-3671, 420 S. San Pedro St., Los Angeles, Cal.

IN PRODUCT IMPROVEMENT **RCA** *NEVER STANDS STILL*

RADIO CORPORATION of AMERICA
ELECTRON TUBES **HARRISON, N. J.**

Want more information? Use post card on last page.

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IN DIALS
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eye-appeal?
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You get them all when they're
"U. S. RADIUM"!
When you specify U. S. Radium dials or nameplates, you get *accuracy* because we've had many years' experience in making high-accuracy dials for scientific instruments. You get *eye-appeal*, whether you provide your own design or have us design the unit for you, because we've designed and produced millions of dials and nameplates — including dials for well-known makes of watches and clocks. You get *low-cost* because, in producing so many dials and nameplates, we've developed mass-production techniques that save money. And as for *variety* — nowhere else can you get a selection like this! We make self-luminous, fluorescent, phosphorescent, and *non*luminescent types, including Alumilite, lithographed or etched aluminum, brass, steel, or stainless steel — finished in lacquer, nickel, chromium, or silver — with black, color, or luminescent markings. We are, of course, equipped to meet Government specifications.
To find out how accurately and economically we can meet your dial or nameplate requirements, write to *Dept. E2, U. S. Radium Corp., 535 Pearl Street, New York 7, N. Y.*
Other Products of U. S. Radium
RADIOACTIVE FOILS (alpha-ray ionization sources)
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RADIUM LOCATORS: lenses, buttons, screws, markers
LUMINOUS RETICLES and other specialties
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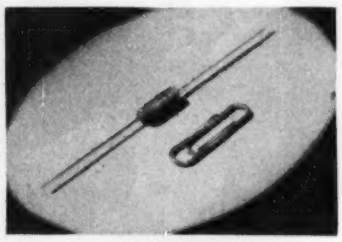
for military contracts. Specifications and prices are available from the company.

Direct-Drive Yokes

HALLDORSON TRANSFORMER CO., 4500 N. Ravenswood Ave., Chicago 40, Ill., is currently supplying their new 6,000-v test deflection yokes, DR603 and DF604, extra-heavily insulated to stand up under the rigors of direct-drive tv service. Both deflection yokes have 30-mh horizontal inductance, but to cover all direct-drive applications, the vertical inductance of DF603 is 3.5 mh, while DF604 is 50 mh. Both yokes are supplied with 20-in. color-coded leads and networks. Bulletin 109 fully describes the deflection yokes discussed.



Tiny Capacitor

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass., has developed a very tiny molded paper capacitor for continuous operation at temperatures up to 125 C. Designated type 85P, these capacitors are impregnated with Prokar, an exclusive high-temperature organic material which is polymerized to a

Magnetic Amplifiers

Keystone is one of the nation's foremost suppliers of magnetic amplifiers. Effective immediately we have available for prompt delivery the first of five "stock" magnetic amplifiers. Engineers may now design units around these "pre-designed" magnetic amplifiers. Inquiries are invited on the

"MotoMag"

Registered Trademark of Keystone Products Co.

In place of the conventional output transformer and power amplifier tubes, the KP 10-400 utilizes a phase sensitive vacuum tube demodulator and magnetic amplifier output stage which eliminates the need of rectifiers, thus assuring greater reliability. Each unit built in accordance with MIL specifications. KP 10-400 operates from an input voltage of 115 volts, 400 cycles single phase. Output is 10 watts, reversible phase. KP 10-400 operates from a minus 55° to plus 70° C with minimum variation. An input signal of 2 volts AC or DC working into a high impedance is required for a maximum of 110 volts, 10 watts, 400 cycles. The unit is 4 inches high, 3½ inches wide and 2½ inches deep. Weight—only 1 lb., 13 ounces.

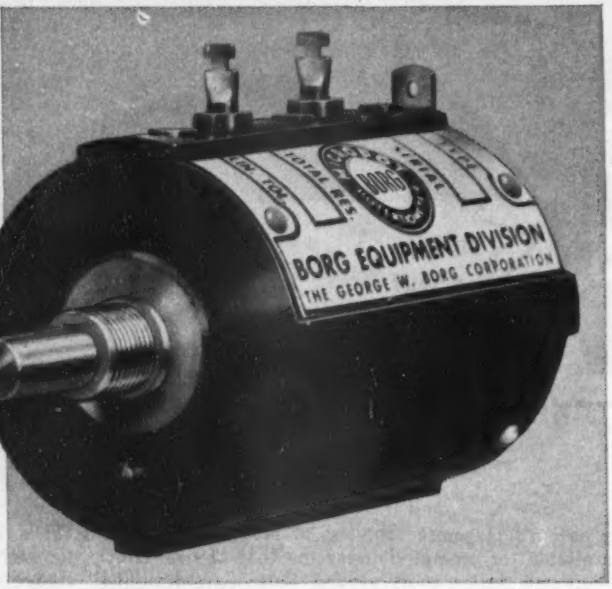
Your inquiry will have our prompt attention.

KEYSTONE PRODUCTS CO.

904-6 TWENTY-THIRD ST., UNION CITY 2, NEW JERSEY

UNion 6-5400

THE HIGH-PRECISION LINEAR POTENTIOMETER

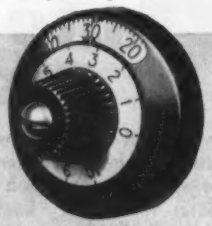


MICROPOT
precision ten-turn potentiometer

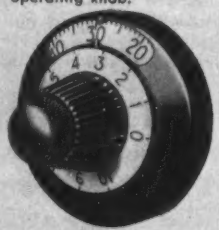
BORG MICROPOT TEN-TURN POTENTIOMETER: Built to fit the specifications of control system engineers and designers . . . constructed with Micro accuracy for precise voltage adjustments . . . featuring an assembly scientifically designed, machined, assembled and automatically machine tested for linearity of ±0.1% and 0.05%, *zero-based*. MICROPOTS ARE AVAILABLE IN 1.15 to 3 OHM and 30 to 250,000 OHM RANGES FOR IMMEDIATE SHIPMENT.

BORG MICRODIAL: Two concentrically mounted dials: one for counting increments of each turn and the other for counting turns . . . delivered completely assembled with dials synchronized. Outstanding features include smooth, uniform action . . . no backlash between incremental dial and potentiometer contact . . . less wear, only one moving part aside from the two dials . . . contact position indicated to an indexed accuracy of 1 part in 1,000.

MICROPOT—MICRODIAL CATALOG SENT PROMPTLY ON REQUEST



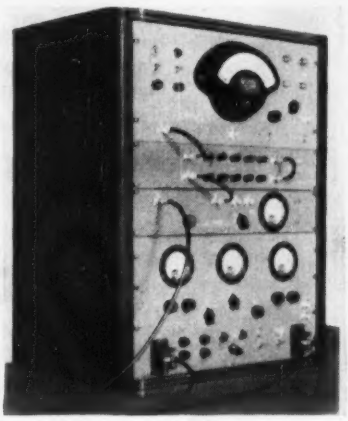
BORG MICRODIAL 746-A
A precision ten-turn indicating dial assembly. Has screw locking device on operating knob.



BORG MICRODIAL 746-B
Same as 746-A but has knurled locking screw mounted externally to operating knob.

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
Janesville • Wisconsin

solid resin. The resulting dielectric is completely solid and permits considerable size reduction with extreme stability under all operating conditions. The impregnated sections are then molded in a mineral-filled, high temperature plastic. Originally developed for military use, these miniatures are now available for precision electronic equipment requiring high-quality components such as electronic computers and geophysical amplifiers. Type 85P units are available in 2 molded sizes—0.175 in. diameter x $\frac{3}{8}$ in. long and 0.200 in. diameter x $\frac{3}{8}$ in. long. Standard RTMA 20-percent and 10-percent capacitance decade values are available as well as 5-percent values.



Microwave Gain Set

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The microwave gain set illustrated is a complete equipment for making precision measurements of gain or loss in microwave components or systems, and it can also be adapted for use down to the vhf range. Unusually high precision is attainable, since the gain set, which is readable to 0.025 db, is capable of measurement accuracy within 0.1 db of the attenuator calibration. Measurements can be made where available power is as low as −80 dbm. In order to measure the gain, loss, standing-wave ratio, or other properties of a microwave system or component, energy of the desired frequency is sent through the component under test and then received by a microwave receiver. The microwave gain

KLIXON

C6360

MOTOR STARTING RELAY LEADS

ARE INSULATED AND PROTECTED

The KLIXON C6360 is a current type relay which means that the entire motor current flows through it. Therefore the wire in the coil winding is heavy enough to be used for leads, eliminating screw terminals. And since sleeves of Natvar 400 are reasonably low in cost, and are easily slid over the leads, assembly is quicker and less expensive. Also, leads can be color coded, because Natvar 400 is furnished in bright, distinctive colors.

NATVAR 400

EXTRUDED PLASTIC TUBING

KLIXON Protective devices and controls, manufactured by Spencer Thermostat Division of Metals & Controls Corporation, are used by foremost makers of refrigerating and other electrical equipment to assure safe, continuous operation under all service conditions.

Since reliability of KLIXON devices is essential, only the best materials are used. Natvar 400 extruded plastic tubing has been selected as the most suitable lead insulation for the starting relay shown above because of its excellent physical and electrical properties and its dependable uniformity.

Natvar 400 and other Natvar flexible insulating materials are available either from your wholesalers stock or direct from our own.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
- Silicone coated Fiberglas
- Varnished papers
- Slot insulation
- Varnished tubing and sleeving
- Varnished identification markers
- Lacquered tubing and sleeving
- Extruded plastic tubing and tape
- Extruded plastic identification markers

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NATVAR CORPORATION

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MARKEM SOLVED THIS MARKING PROBLEM

PRINTING LABEL INFORMATION ON CARTRIDGE ENCLOSED FUSES

Working closely with Underwriters' Laboratories, Inc. and with leading fuse manufacturers, Markem has developed a method which makes possible for the first time the printing of label information directly on cartridge enclosed fuses at production rates. Markem's direct ink imprints cannot "fall off" and are unaffected by moisture or ordinary chemical atmospheres. Paper label inventory and wastage problems are eliminated. Print is larger and color coding and identification are simplified. Fuse manufacturers anticipate better labeling at higher production rates and with lower costs. The Markem Method —Markem Machine, Markem type and ink and the special recording die roll for use when UL Manifest is required—as well as the imprint itself meet with UL approval.

MARKEM® MARKS THEM ALL

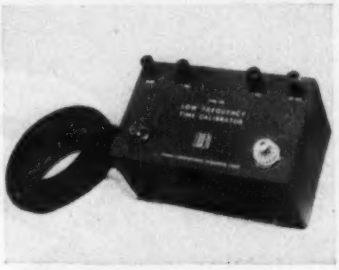
CAN MARKEM HELP YOU? Printing labels directly on cartridge enclosed fuses is but an example of how Markem solves industry's marking problems. Markem has been providing industry with production techniques and equipment to identify, decorate or designate its products, parts and packages since 1911. Markem also provides technically trained men who are available in your area to assure *continued* satisfaction with Markem methods and equipment.

When *you* have a marking problem, tell us about it and send a sample of the item to be marked. Perhaps a complete Markem method has *already* been developed to solve your problem. If not, Markem will work out a practical solution.

Markem Machine Company, Keene 5, N. H., U.S.A.

MARKEM ...TO MAKE YOUR MARK

set is available with or without r-f heads, and it may be used in conjunction with a klystron signal source and a local oscillator for any frequency range.

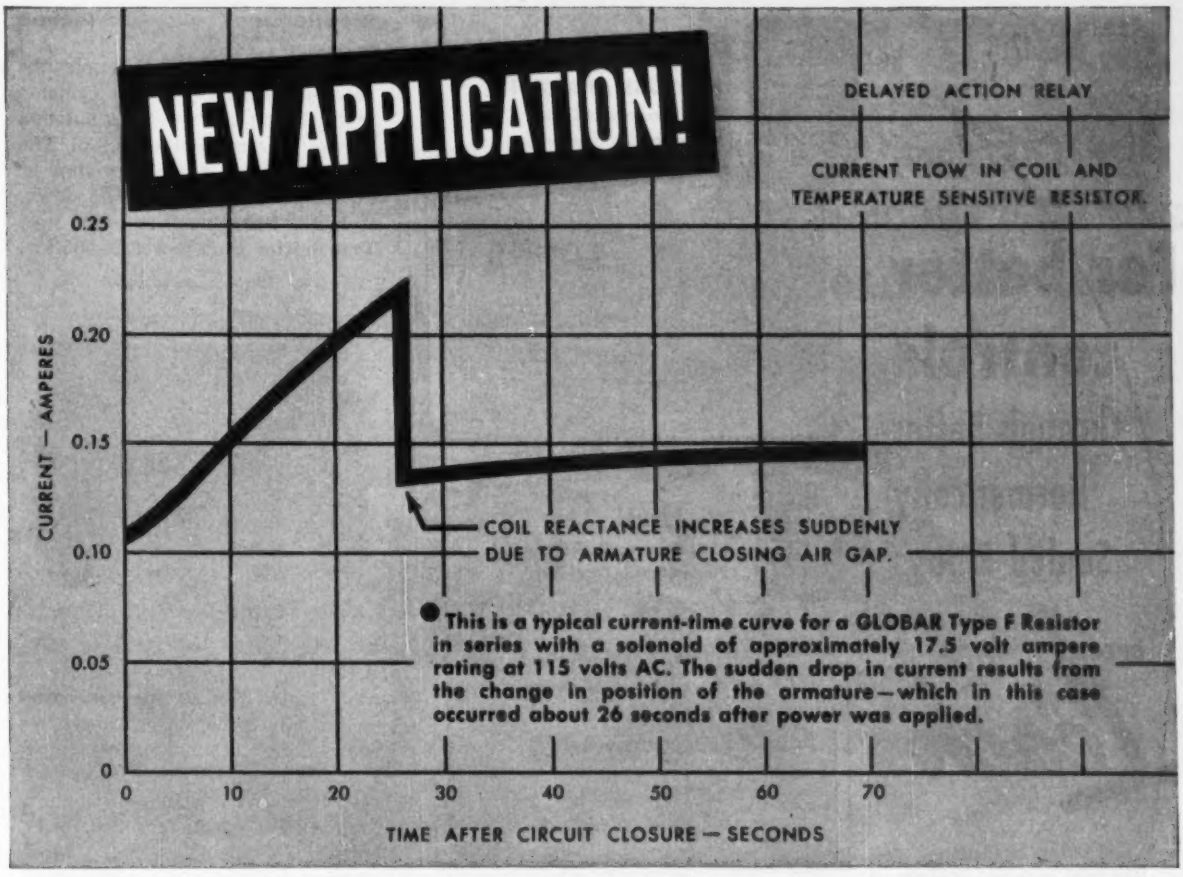


L-F Time Calibrator

OWEN LABORATORIES, 9130 Orion Ave., San Fernando, Calif. The type 190 low-frequency time calibrator is a synchronous-motor driven device furnishing pulses at intervals of 0.01, 0.1, or 1.0 second. It is intended for use with oscilloscopes and various types of recording equipment in electrical, mechanical biological investigations. Pulse amplitude is about 1.5 v. Size is $5\frac{1}{4} \times 3\frac{1}{4} \times 3$ in.

Gas-Switching Tube

GENERAL ELECTRIC CO., 1 River Road, Schenectady 5, N. Y. Type GL-1B24-A gas switching tube for airborne radar is an integral-cavity tunable type designed for use in simple duplexers in pulsed microwave circuits which do not require that the short circuit in the tube have a fixed electrical position. The tube is designed for use in an operation band of from 8,490 to 9,600


NEW APPLICATION!
DELAYED ACTION RELAY
CURRENT FLOW IN COIL AND TEMPERATURE SENSITIVE RESISTOR.
CURRENT — AMPERES
0.25
0.20
0.15
0.10
0.05
0
COIL REACTANCE INCREASES SUDDENLY DUE TO ARMATURE CLOSING AIR GAP.
This is a typical current-time curve for a GLOBAR Type F Resistor in series with a solenoid of approximately 17.5 volt ampere rating at 115 volts AC. The sudden drop in current results from the change in position of the armature—which in this case occurred about 26 seconds after power was applied.
0
10
20
30
40
50
60
70
TIME AFTER CIRCUIT CLOSURE — SECONDS

Simple, maintenance-free TIME DELAYS with GLOBAR Type F Resistors

Now time delays in many relay and solenoid circuits are being obtained inexpensively by simply connecting a GLOBAR Type F Ceramic Resistor in series with the actuating coil. Delays range from a few seconds up to two minutes, depending upon the values and sizes of the resistors used.

When power is applied in the circuit, the current through the resistor causes it to heat. As it heats, its resistance decreases and the current increases until the tripping value of coil current is reached.

It's simple, inexpensive, and maintenance-free—and requires less space than dash-pots or other more complicated delay devices. It is useful in single delay applications—as in the starting of critical electron tubes; or in multiple delay applications where fixed timing of a series of events is necessary—as in the starting of oil burners.

If you have a time delay problem—or any circuit problem where long-life GLOBAR Ceramic Resistors might provide the answer—let our engineers help you. Just send complete circuit information to Dept. E 87-31.

GLOBAR Ceramic Resistors

TRADE MARK

by CARBORUNDUM

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company, Niagara Falls, New York

87-31

For better controls through better Hermetically Sealed Relays

SPECIFY *Leach*

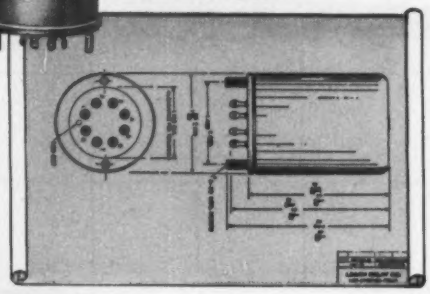
The most advanced hermetically sealed relays can best be designed and produced by a firm like *Leach* which pioneered this field from the beginning.

Here at *Leach* you will find complete engineering, testing and production facilities to help you solve your relay problems in the electrical and electronic fields.

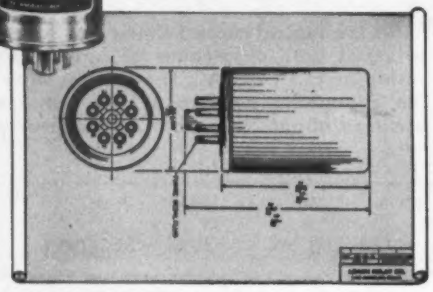
The unsurpassed dependability of *Leach Relays* has been proved by nearly *four decades* of leadership in providing all types of relays for maximum performance under competitive operating conditions.

FOR BETTER CONTROLS THROUGH BETTER RELAYS
—Specify Leach

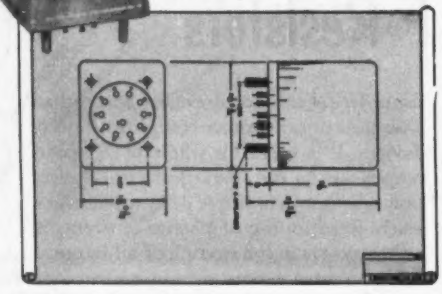
No. 637SS, AN3307-1
2PDT Hermetically Sealed, Solder Terminal Type



No. 637PS
2PDT Hermetically Sealed, Plug-In Type in Octal Plug



No. 9031SS
3PDT Hermetically Sealed, Solder Terminal Type



Performance characteristics for the Relays illustrated above are as follows:

- **Contacts rated: 10 Amps. Resistive and inductive at 29 VDC.**
- **6 Amps. Motor load at 29 VDC.**
- **10 Amps. Resistive at 115 VAC, 400 cycles. Coil 24-28 VDC.**

LEACH RELAY CO.

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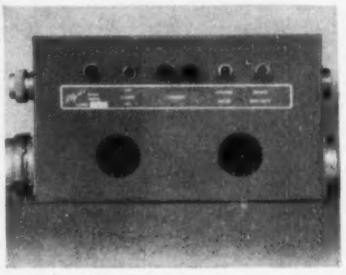
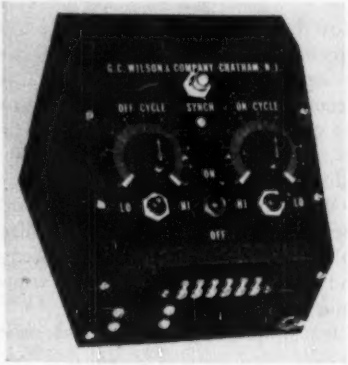
Representatives in Principal Cities of the U.S. and Canada

mc. It operates to decouple the receiver effectively from a common transmitting and receiving antenna during a transmission period. The GL-1B24-A has a recovery time of 4 μsec at 10 kw peak, 3 db down. It has a leakage power of 30 mw. Transmitter peak power is 100 kw.



Cable Tester

LLOYD'S ENTERPRISES, Box 313, Altadena, Calif., has available a cable tester for testing multiconductor cables for opens, shorts between any other conductor or shorts to ground. The model LK24-7 tests the TV24 conductor camera cable (three conductors are coax) and the RCA field sync generator 7 conductor cables. Any combination with standard fittings can be supplied upon request. The buzzer is normally used to indicate continuity or shorts, but binding posts are supplied so that an external ohmeter can be used if desired.



Repeat Cycle Timer

G. C. WILSON & Co., 2 North Passaic Ave., Chatham, N. J. Model No. 1 electronic repeat cycle timer is suitable for regulation of automatic machinery, sampling, valve pacing and heat sealing as well as

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D.C. OUTPUT		CATALOG NO.	
VOLTS	AMPERES	115 V.A.C 60 ~ 1ϕ	230 V.A.C. 60 ~ 1ϕ
O-6	25.0	K38	—
	50.0	K47	K48
	100.0	K56	K57
O-12	12.5	K65	—
	25.0	K74	K75
	50.0	K83	K84
O-28	10.0	K92	—
	20.0	K101	K102
	40.0	K110	K111

The OPAD-GREEN General Purpose Power Supplies are designed to furnish an adjustable source of unfiltered direct current from single phase 50 or 60 cycle A.C. power lines. A unique feature is their stepless control of the D.C. output voltage which permits them to serve as power sources for a wide variety of electrical equipment and electro-chemical processes. *For additional information write for Bulletin No. 147*

Opad-Green COMPANY

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OVER 200 BASIC TYPES TO CHOOSE FROM

Do audio attenuator problems cost you money? Chances are Shallcross has a model to match your specifications exactly—and at moderate cost.

Shallcross attenuators are made in over 200 basic types. Each type can be supplied with a choice of attenuation characteristics . . . with a positive detent mechanism . . . and in numerous input and output impedances. Where calibration must be extremely accurate, Shallcross precision wire-wound resistors are used. For less critical applications, models with high grade composition resistors can be supplied—often at lower cost.

A complete description of all Shallcross attenuators — mountings, characteristics, and circuits is yours for the asking in Bulletin L-4A. SHALLCROSS MFG. CO., 522 Pusey Avenue, Collingdale, Penna.

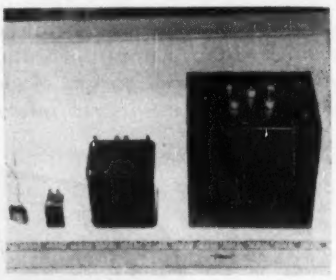
QUICK DELIVERIES! Small quantities of popular 20 step Shallcross composition resistor potentiometers and wire-wound ladders without detents are immediately available.

Shallcross

laboratory testing such as heat cycling and refluxing. The timer uses a single electron tube to charge a resistance-capacitance network so that on cycles are adjustable from 0.2 to 200 seconds and off cycles range from 0.1 second to 1 minute. The unit is supplied in a 6 × 6 × 6-in. cabinet for operation on 105 to 120-v, 60-cycle a-c. Output is supplied to a dpdt relay for noninductive loads up to 10 amperes at 115 v or 2 amperes at 460 v. Relay contacts are wired to a plug or a terminal strip to facilitate installation.

Frequency Standard

AMERICAN TIME PRODUCTS, INC., 580 Fifth Ave., New York 36, N. Y. Type 2007 hermetically sealed frequency standard contains a shock-mounted miniature high-Q tuning fork, a subminiature double triode tube and all circuitry. Output frequencies available are 400 or 500 cycles with an accuracy of ±1 part in 50,000 from 15 to 35 deg C and ±1 part in 5,000 from −65 to +85 deg C. It is sealed in an octal base container, 1½ in. in diameter and 4½ in. high. It weighs less than 10 oz. Power required is 75 to 200 v d-c at 1 to 5 ma, and 6.3 v at 300 ma. It is designed to withstand MIL environment.



Transformers

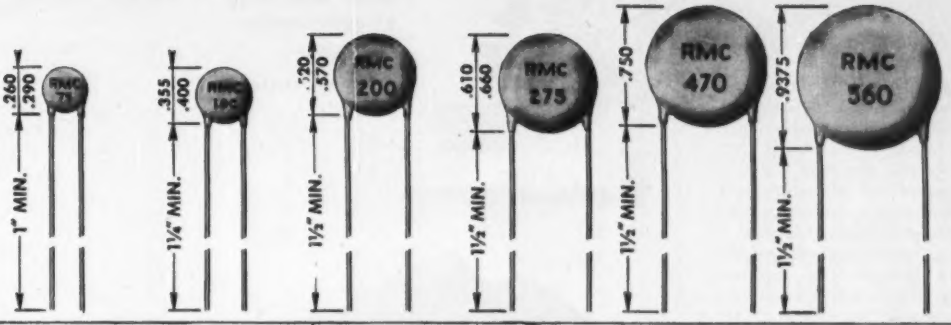
A.J.F. INDUSTRIES, INC., 852 Monroe St., Brooklyn 21, N. Y., is now

RMC

Temperature Compensating as well as By-Pass

DISCAPS

are Rated at 1000 Working Volts!



TC	1/4 Dia.	5/16 Dia.	1/2 Dia.	5/8 Dia.	3/4 Dia.	7/8 Dia.
P-100	—	2– 9 MMF	10– 30 MMF	—	—	—
NPO	2– 12 MMF	13– 27	28– 60	61– 75 MMF	76–110 MMF	111–150 MMF
N– 33	2– 15	16– 27	28– 60	61– 75	76–110	111–150
N– 80	2– 15	16– 27	28– 60	61– 75	76–110	111–150
N– 150	2– 15	16– 30	31– 60	61– 75	76–110	111–150
N– 220	2– 15	16– 30	31– 75	76–100	101–140	141–190
N– 330	2– 15	16– 30	31– 75	76–100	101–140	141–190
N– 470	2– 20	21– 40	41– 80	80–120	121–170	171–240
N– 750	5– 25	26– 50	51–150	151–200	201–290	291–350
N–1400	15– 50	51–100	101–200	200–250	251–470	480–560
N–2200	47– 75	76–100	101–200	201–275	276–470	471–560

If the samples you need are not here — send for them.

SPECIFICATIONS

POWER FACTOR: LESS THAN .1% AT 1 MEGACYCLE

WORKING VOLTAGE: 1000 VDC TEST VOLTAGE: 2000 VDC

DIELECTRIC CONSTANT: P-100 14K N-750 88K N-2200 265K NPO 35K N1400 165K

CODING: CAPACITY, TOLERANCE AND TC STAMPED ON DISC

INSULATION: DUREZ PHENOLIC—VACUUM WAXED

LEAKAGE RESISTANCE: INITIAL 7500 MEG OHMS AFTER HUMIDITY 1000 MEG OHMS

LEADS: #22 TINNED COPPER (.026 DIA.)

LEAD LENGTH: ¼" BODY 1", ⅜" BODY 1¼", ½" AND LARGER BODY 1½"

TOLERANCES: ±5%, ±10%, ±20%

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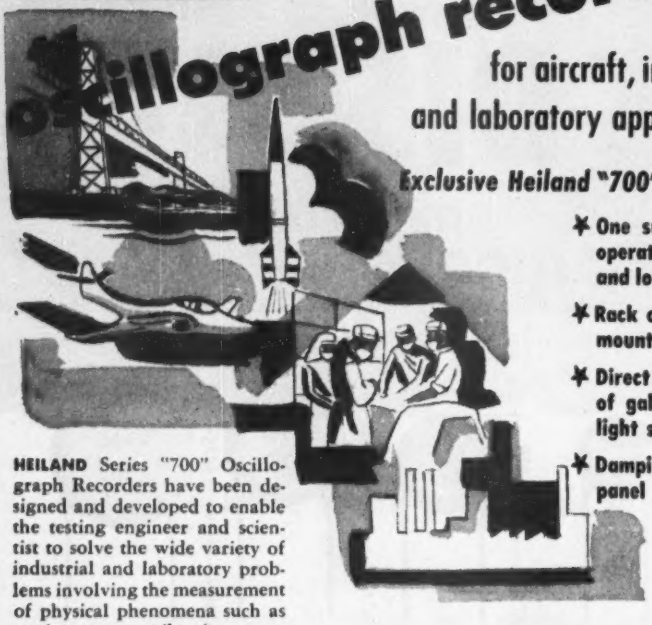
for aircraft, industrial and laboratory applications



Exclusive Heiland "700" Features

- One surface operation, control and loading
- Rack or table mounting
- Direct monitoring of galvanometer light spots
- Damping resistor panel

HEILAND Series "700" Oscillograph Recorders have been designed and developed to enable the testing engineer and scientist to solve the wide variety of industrial and laboratory problems involving the measurement of physical phenomena such as strains, stresses, vibrations, pressures, temperatures, accelerations, impact, etc. Accurate and dependable oscillograph records permit the study of various recorded data comparatively, individually and collectively making for better product design and performance.

HEILAND Series "700" Oscillograph Recorders are being widely used today for the analysis of static and dynamic strains, vibrations, etc. in aircraft and guided missile flight testing; structural tests; performance tests; riding quality evaluation; voltage and current measurements; medical research; general industrial problem analysis.

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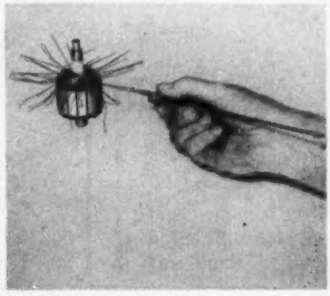
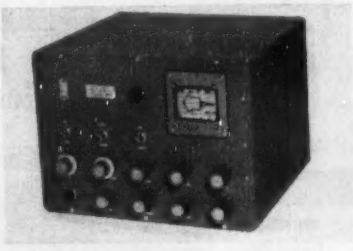
producing hermetically sealed transformers per MIL-T-27 specifications in quantity. Sizes range from the sub-subminiature (less than ½ oz) to 1 kva for the audio, power, plate and filament for temperature rise of 40C at 65C ambient and are made grade 1 with can and also encapsulated without the can. They are manufacturing high temperature 200C transformers which are made hermetically sealed; and pulse transformers ranging in size from trigger and blocking oscillator units of 300 v peak secondary to pulse units of 80 kw peak power and 10 kv peak volts.



Wire Twister

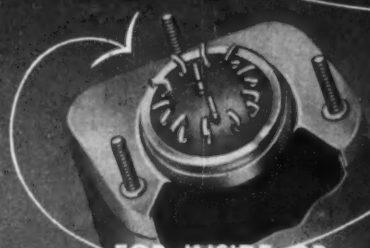
THE ERASER CO., INC., RUSH WIRE STRIPPER DIV., 114 S. State St., Syracuse 2, N. Y. Designed for uniform, low-cost wire twisting, this new wire twister consists of a spiral rod with hooks on both ends and a follower shaped to fit the thumb and forefinger. With the followers at one end, the wire is attached to the hook on that end and the follower drawn the full length of the spiral rod. Then the unit is turned end for end and the operation repeated. The No. G-3 is designed for 6 turns; the No. G-4, for 12 turns.



Servo Tester

INDUSTRIAL CONTROL CO., Wyandanch, Long Island, N. Y. The

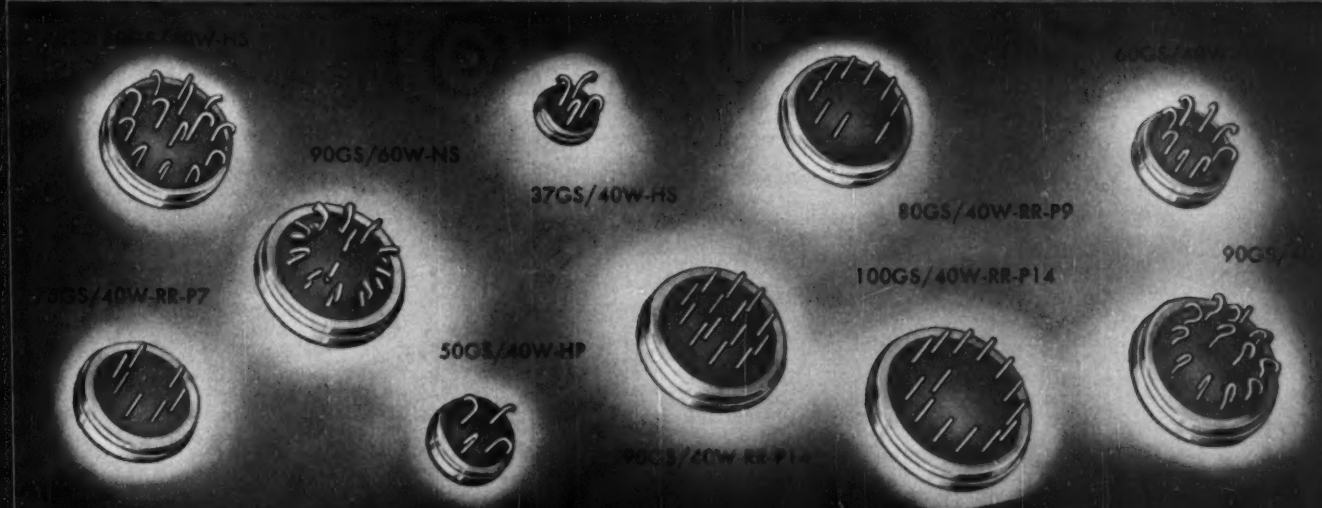
Introducing the new E-I GS SERIES MULTIPLE HEADERS



FOR INSIDE OR OUTSIDE MOUNTING

...specially designed for relay closures and similar applications

New GS Series multiple headers are another step forward in standardization by E-I engineers. They offer engineers in electronic and electrical design a selection of economical standard components that solve most, if not all, problems of hermetically sealed terminals for relay closures and similar applications. Over 200 standard headers are now available for this type of service. For complete information on other types, consult the bulletin described below.



- RUGGEDLY DESIGNED FOR EXTRA DEPENDABILITY
- MANY TYPES AVAILABLE WITH EXHAUST TUBES
- WIDE RANGE OF SIZES FOR ALL REQUIREMENTS
- STANDARD TYPES FOR MAXIMUM ECONOMY

E-I . . . your Headquarters for Hermetically-Sealed Multiple Headers, Octal Plug-Ins, Terminals, Color Coded Terminals, End Seals, etc.

WRITE FOR NEW E-I MULTIPLE HEADER BULLETIN 950-B!

Includes the complete line of E-I Standard Multiple Headers which offer an economical solution to practically any problem of design involving hermetically sealed terminals.

DIVISION OF AMPEREX ELECTRONIC CORP.

ELECTRICAL INDUSTRIES

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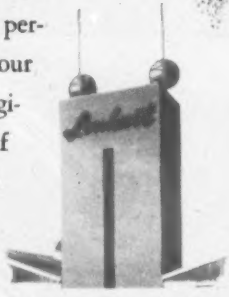
all this performance

and miniaturization too!

By the use of 18 Lenkurt precision-wound wedding-ring toroids, the two bandpass filters shown at right were redesigned into a single hermetically-sealed plug-in unit, as shown at left. Volume was reduced from 179 cu in. to 36 cu in., a factor of 5 to 1. But, at the same time, performance was actually improved.

Whenever your military or commercial designs call for maximum filter or toroidal-coil reliability under adverse service conditions, and where exacting electrical performance must be maintained, bring your problems to Lenkurt. The Lenkurt engineering group has a rich background of experience from which to offer valuable suggestions in the matter of setting practical specifications to attain the utmost from materials, components and techniques.



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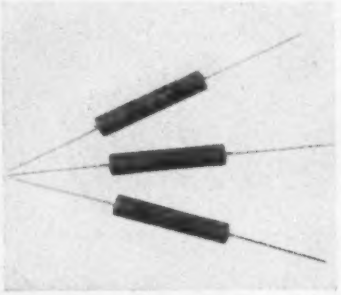
Lenkurt

101-A servo tester is designed for the rapid field maintenance and production testing of servo systems by technical personnel using no additional instrumentation. The transient response of the loop under test is shown on a 3-in. c-r screen, and viewed through a mask onto which has been previously drawn the response specified by the manufacturer. The operator adjusts the servo loop to match the two traces; if this is not possible, the loop is declared inoperative and returned to a laboratory area or maintenance depot for repairs. A standard servo test receptacle is installed on the equipment to be checked, and wired into the data system. A single cable connects this plug to the 101-A. The tester can be used with d-c and carrier frequency servos, and operates from the 117 v 60 or 400-cycle line.



Power Resistor

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., has added to its line a new power resistor, type PW4, rated at four watts. Completely insulated with an inorganic core material molded in a high temperature plastic, this unit will not support combustion. The wire element is uniformly and tightly wound on glass fibre core with axial leads 1½ in. long and 0.036 in. in diameter. Body dimensions are 1¾ in. long x ¾ in. in diameter. The resistor is available from 1 ohm to 8,200 ohms in ±5.0 percent and ±10.0 percent tolerance. It is particularly recommended for tv circuits requiring 2 to 3 w actual dissipation at high ambient temperature, as resistance element of resistance—capacitance filter in automobile receiving sets where operation is at high ambient

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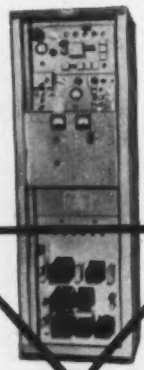
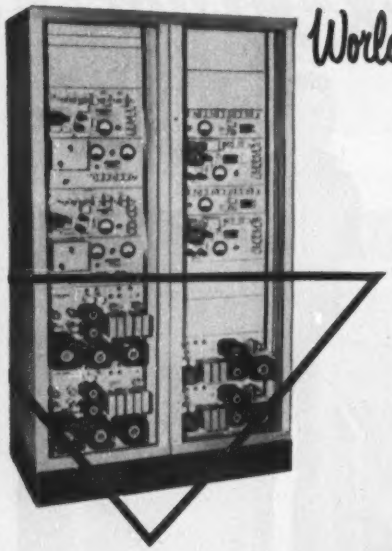
talk about a beating!

multiplex radio telephony systems must take it...



that's why REL specifies CHICAGO



World's Toughest Transformers

Absolute dependability under the most rugged operating conditions is a prime requirement in all REL Multiplex Radio Telephony Systems. That's why you'll find CHICAGO "Sealed-in-Steel" transformers used throughout REL equipments. These world's toughest transformers are available in 3 mountings, each featuring one-piece seamless design enclosing an electronically perfect construction. Available for *every* application: Power, Bias, Filament, Filter Reactor, Audio, MIL-T-27, Stepdown. Ask for them at your electronic parts distributor.

Illustrated above at right: REL 900 MC Transmitter, Series 707-757. Illustrated immediately above: REL Model 759 70 MC Dual Transmitters and Receivers. These systems make wide use of CHICAGO C-Type "Sealed-in-Steel" transformer units.

C-TYPE
With 10" color-coded leads brought out through fibre board base cover. Lead ends are stripped and tinned for easy soldering. Flange-mounted unit.

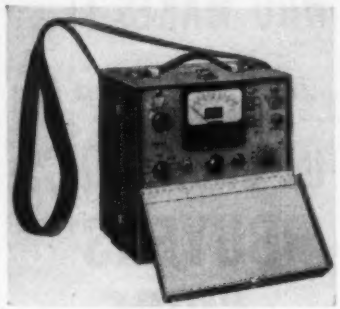
Free "New Equipment" Catalog

You'll want the full details on CHICAGO'S *New Equipment Line*—covering the complete range of "Sealed-In-Steel" transformers designed for every modern circuit application. Write for your Free copy of this important catalog today, or get it from your electronic parts distributor.

CHICAGO TRANSFORMER
DIVISION OF ESSEX WIRE CORPORATION
3501 ADDISON STREET, CHICAGO 18, ILL.

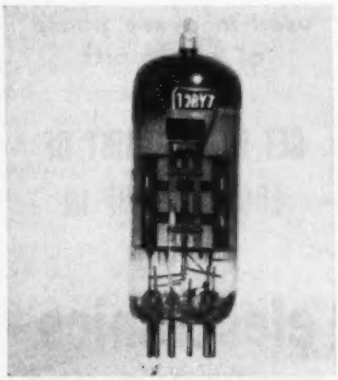
Export Sales Div.: Scheel International, Inc. 4237 N. Lincoln Ave. Chicago, Ill., U.S.A.
CABLE ADDRESS: HARSHEEL

temperature, and all other circuits where a stable resistor is required, with wattage dissipation of 4 watts and less.



Field Strength Meter

JERROLD ELECTRONICS CORP., N. E. Cor. 26th & Dickinson Sts., Philadelphia 46, Pa., has developed the model 704 field strength meter that is designed to bridge the gap between ultra-expensive laboratory models and the simple-type field meters which provide only a relative indication of signal strength. It is a direct-reading meter for tv and f-m and will read in microvolts. The unit is accurate to ±0.8 db and has a continuous tuning range from 50 to 220 mc. Model 704 separates and measures video, audio and adjacent channel carriers, and locates r-f interference.



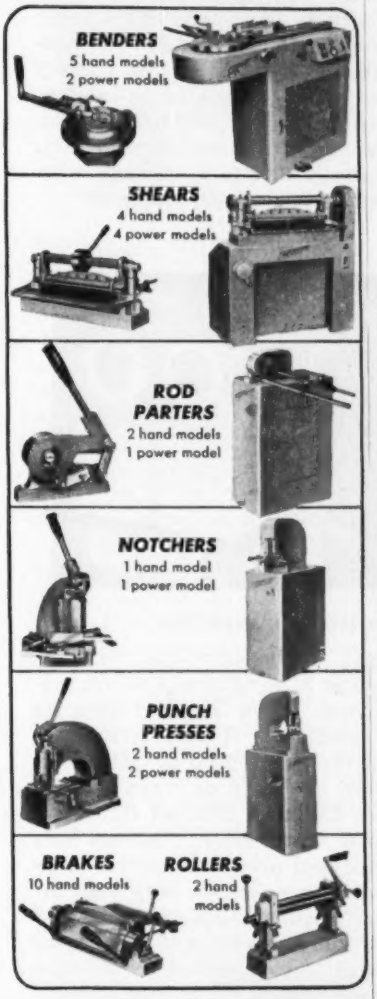
Television Pentode

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa., has in production a new television pentode, the 12BY7. It is a high-transconductance, sharp-cutoff video amplifier de-

di-acro

PRECISION MACHINES

for Die-less Duplicating



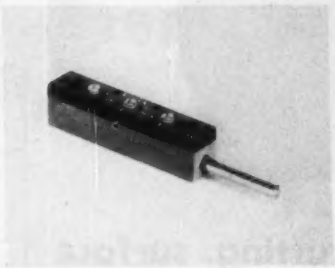
NEW CATALOG
packed with ideas for making parts by "Die-less Duplicating"—the money-saving, time-saving technique created by Di-acro.

BENDING MANUAL
gives exact methods for bending processes in a variety of materials. Over 90 diagrams and charts with suggestions.

Sent on Request

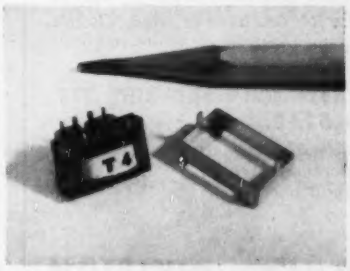
O'NEIL-IRWIN MANUFACTURING CO.
321 8th Ave., Lake City, Minnesota

signed for service in tv receivers. The tube features miniature T-6½ construction, and will furnish large output voltages across low values of load resistance and supply voltage. The separate suppressor grid connection allows the 12BY7 to be used for more diversified applications. The heater may be operated from either 6.3 or 12.6 v.



Linear Motion Potentiometer

BOURNS LABORATORIES, 6135 Magnolia Ave., Riverside, Calif. The new linear motion potentiometer with precision wire-wound resistance elements was designed for airborne and industrial electronic systems. Linearity, tested by the continuous calibration method is ±0.5 percent or better. A resolution of 0.001 in. is attainable with standard shaft travels of 1⅛ (model illustrated), 2½, 4 and 6 in. The potentiometer will withstand sustained acceleration of 100 g's and vibration of more than 1,000 cps. Standard resistances range from 1,000 to 50,000 ohms. An output of at least 26 v is attainable from the unit. Size is ⅝ in. x ½ in. x 2½ in. Weight is 1¼ oz.



Miniature Transformer

FORTIPHONE LTD., 247 Regent St., London, W.1, England. Type T.4 miniature transformer has been

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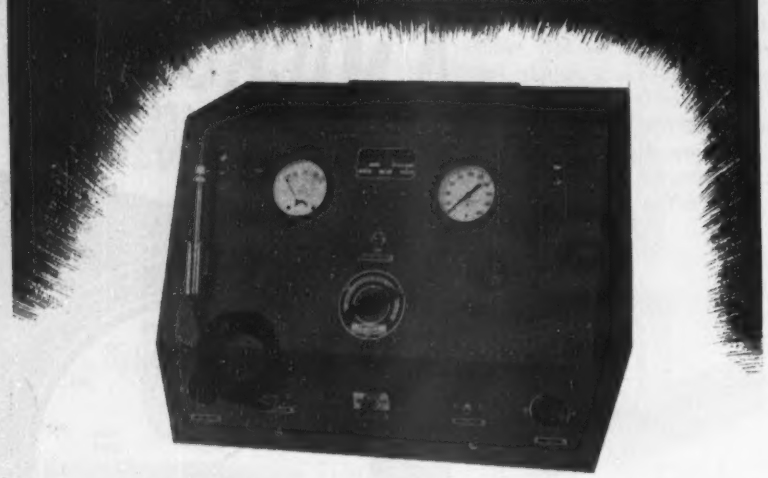
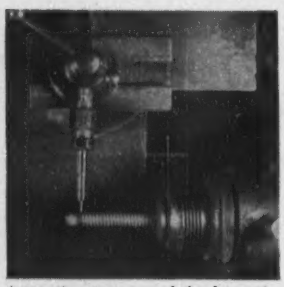


Ideal for high precision cutting, surface film removal, etching and light deburring



Automatic set-up on a lathe for cutting spiral bands on a deposited carbon resistor.

Cutting a piece of hard, brittle metal manually by means of the "Airbrasive" process.

This remarkably versatile machine can be used for a wide variety of high precision operations from cutting hard, brittle materials to producing fine matte surface finishes.

Using a high speed jet of gas-propelled abrasive particles, it can produce cuts as fine as .018" diameter. Its basic advantages are that it cuts cool and without shock or vibration – its accuracy is unaffected by surface irregularities of the work–and it can be accurately regulated for depth and type of cut.

Many manufacturers are now using the Unit to remove surface coatings on deposited carbon resistors and on printed circuits – for light deburring on inside surfaces of tubular parts – drilling fine holes through glass – cutting germanium.

We will be glad to make tests to determine the suitability of the "Airbrasive" Unit to your production requirements. Send us a sample of the part or material as well as details of the job you have in mind. There's no obligation.

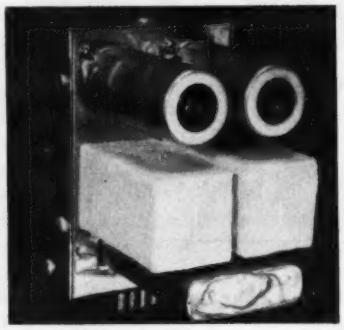
WRITE FOR BULLETIN 5212

It has full facts and data on the Airbrasive Unit. It tells you how the "Airbrasive" Unit works and provides information on where, when and how it can be used.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. E, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

designed for use as an output transformer in hearing aids and similar miniature equipment. The windings of the transformer are brought out to terminals molded into the robust thermosetting plastic material of the bobbin. A laminated core of high permeability magnetic alloy is used. All coils are tested to insure that there are no short circuited turns and each completed transformer is checked for efficiency at three frequencies under typical operating conditions. Insulation resistance between primary and secondary at 500 v d-c is better than 100 megohms. Ratio of primary turns to secondary turns is normally 31.6 to 1 although other ratios are available on request.



Isolation Amplifier

SEAY INSTRUMENT CO., 6521 N. Lamar Blvd., Austin 5, Texas, announces a new amplifier designed primarily for use in driving resolvers and computing potentiometers. Virtually universal application has been achieved through a novel circuit design that has been tried and proven in several large scale computors. A very high input resistance has been obtained through elimination of the conventional input summing resistors normally used. Up to 66 db of negative feedback provides almost complete independence from tube, power supply and frequency variations. The networks for controlling the frequency response of the amplifier are molded in a thermosetting material for stability and simplified packaging. Their broad band design permits use of the amplifier at any carrier frequency from 30 cps to 1 kc. Detailed information on performance, circuit

applications and dimensions are published in technical bulletin No. 1.

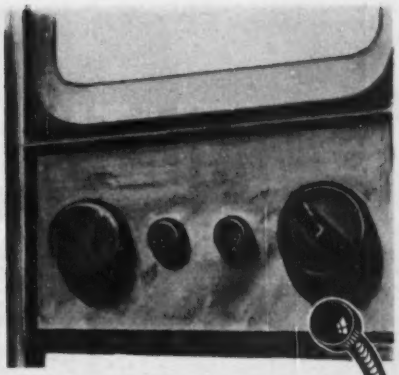
TV Master Switchboard

FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J., has developed a television master switchboard for increased operating control and flexibility. Completely self-contained, the unit permits channeling six separate inputs to six destinations by means of indirect relay switching. These relays may be located in the operating console or at a remote rack. A larger automatic clearing, and automatic termination and automatic holding features have been incorporated, as well as adjustment of the gap or lap switching interval. The built-in fader employs a two-channel video amplifier through which any two incoming signals may be routed. The output signal may then be reinserted as an additional signal source.

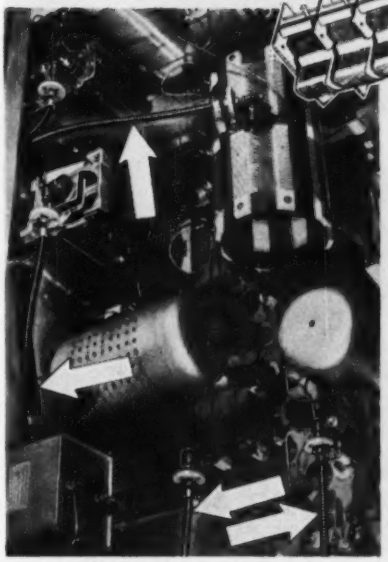
Electronic Micrometer

J. W. DICE CO., 1 Engle St., Englewood, N. J. Model W electronic

Design equipment for more convenient operation



with S.S.WHITE FLEXIBLE SHAFTS



S.S.White flexible shafts – the **low-cost way to provide your equipment with control** —— meet every requirement for convenience, utility and sensitivity. By using them as couplings between control knobs and variable elements, you can bring control to any point in the circuit, regardless of where the elements are placed.

The advantages you gain are many. You are free to place elements anywhere you want them. You **cut costs** because you can dispense with complex systems of gears and pulleys, cut down on extra parts, and shorten assembly time. And you can get an effective grouping of control knobs on cabinets and instrument panels.

You can save yourself a lot of design headaches by using S.S.White flexible shafts. And you can save a lot of valuable time by enlisting the cooperation of an S.S.White engineer in working out details. His services are yours without obligation.

GET THIS 256-PAGE FLEXIBLE SHAFT HANDBOOK

We'll gladly send you this valuable handbook on flexible shaft selection and application. It's full of helpful ideas. Just ask for it on your business letterhead.

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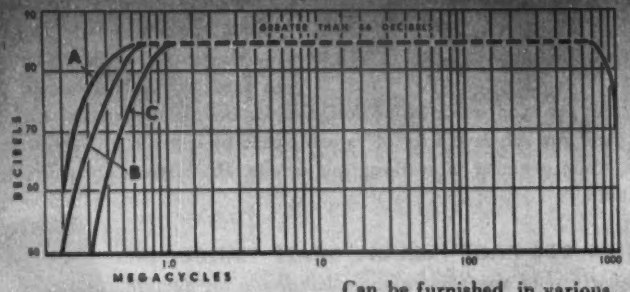
MINIATURE TOBE INTERFERENCE FILTER

- Covers 0.15 to 1000 megacycles
- Handles up to 20 amperes 500 v.d.c./130 v.a.c., 0-1700 cps

In a typical 2 x 2 x 4 in. box you can get more than 80 db attenuation throughout most of the useful range up to 1000 megacycles by using any one of the #1547 series of Tobe interference filters. With their extremely low series resistance, these effective filters have negligible voltage drop and only slight temperature rise. Hermetically sealed, Series 1547 filters meet military specifications for use from 55C to +105C.

ATTENUATION vs. FREQUENCY IN A 50-OHM LINE



Can be furnished in various mounting styles; write for free data sheet giving detailed information.

TOBE

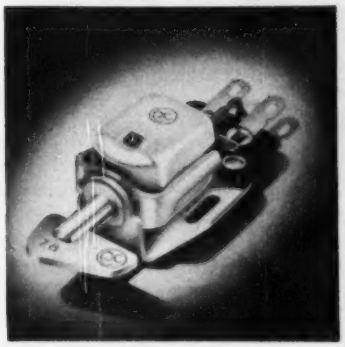
TOBE DEUTSCHMANN
CORPORATION
NORWOOD, MASSACHUSETTS

micrometer permits direct measurements to 0.00002 in. without any measuring pressure being exerted on the work. The measuring head consists of an extremely accurate micrometer screw. An electronic circuit, sensitive to five millionths of an inch displacement at the micrometer tip, gives a visual indication at the moment of contact but before pressure is exerted. Model W is especially designed for use in research, development and performance testing of diaphragms and bellows used in flight instruments, temperature, refrigerator and other types of controls where a pressureless means of testing is required. This new model is an addition to the other models now widely used for measuring thin paper, fine wire, foil, machined parts, springs, radio tube grids and cathodes and other items requiring the highest possible accuracy in a direct measurement.

Miniature Oval Resistors

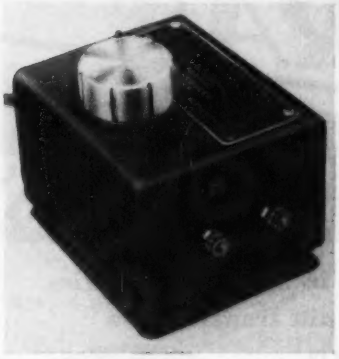
MILWAUKEE RESISTOR CO., 700 W. Virginia St., Milwaukee 4., Wisc., is manufacturing oval type wire wound resistors designed to give higher wattage ratings within small space limitations. These small resistors are equipped with an aluminum mounting strip to provide cooler operating temperatures and greater dissipation of heat caused by intimate contact with the ceramic core. Spacers attached to the ends of the aluminum strip permit easy stack mounting and better heat conduction to the mounting surface. The resistors are available in 10 watts ($\frac{3}{8}$ x $\frac{3}{4}$ in.) and 15 watts ($\frac{3}{8}$ x 1 in.) sizes. They are wound on oval steatite

cores with silver soldered connections and coated with vitreous enamel. Samples are available on request.



Turnover Pickup

PICKERING & Co., Oceanside, N. Y., has developed a new contribution to the technique of recreating recorded music. Model 260 turnover pickup has an output of 30 mv at 10 cm per second; and it mounts easily in any type arm. Detailed literature is available for the writing.



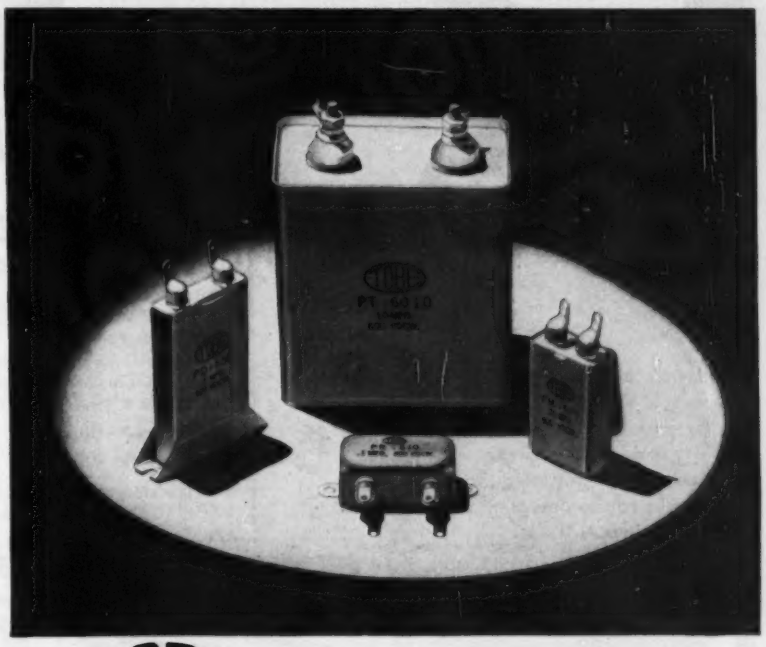
Small Variable Transformer

PACIFIC TRANSDUCER CORP., 11921 W. Pico Blvd., Los Angeles 64, Calif., announces model 226 small variable transformer for portable use in factory and laboratory. With a primary of 117 v a-c, 50 watts, the secondary is from 7 to 13 v a-c continuously variable and 4 amperes continuous duty. It can be used for 6 to 12-v lamps, small motors, heater elements and for operation of a-c relays and solenoids. The unit weighs 3 lb. Its dimensions

RESIN-IMPREGNATED RESIN-FILLED

CAPACITORS

for 125°C service — without derating



TOBE DURATOR CAPACITORS

Higher working temperatures at no increase in size are now possible, with Tobe Durators. Features of these capacitors are:

- Brackets conventional JAN-C types
- 150°C operation for 20 hours without derating
- Welded terminals with silicon insulators
- Hermetically sealed metal cases in bathtub, deep-drawn, and lock-squeeze-seam styles
- Capacitance drift below 7½% from —65°C to +125°C
- Power factor below 1.5% from —65°C to +125°C
- Suitable as coupling capacitors at low signal voltages

Write for data sheet listing available ratings and sizes.

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CORPORATION

NORWOOD, MASSACHUSETTS

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multi-conductor cable

Here's the cable that gives the best in electrostatic and interference shielding—for stationary and portable microphones, speakers, P. A. systems, automobile radios and other electronic devices.

Tinned soft copper conductors are stranded for exceptional flexibility, paper served for easy stripping, individually insulated with low capacitance rubber or polyethylene, in some sizes. Wires are cabled to perfect roundness, cotton served and shielded with tinned copper braid. Outer jacket is either rubber, neoprene or plastic, depending on service requirements.

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solenoid actuated—pneumatically timed

Introduces time delays into a-c or d-c circuits. Easily adjusted to provide delays ranging from 0.1 second to five or more minutes.

The AGASTAT is small, light, and operates in any position. Dust-proof timing chamber assures long operating life with a minimum of maintenance.

Write for Bulletin. Dept. A1-24,

AGA

Division of Elastic Stop Nut Corporation of America
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★ TRANSFORMERS
★ SATURABLE REACTORS
★ ELECTRONIC DEVICES

Specialists in SMALL quantities of custom built transformers from milliwatts to 50 KVA, single or polyphase—designed and manufactured to best meet your exact requirements.

Each Electran Transformer is built to the highest standards of quality and precision. There is no "second" grade of Electran.

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Want more information? Use post card on last page.

are 3¼ in. × 4 in. × 3½ in. high. Each unit is supplied with a 6-ft a-c cord.

Miniature Connector Hood

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y., announces the addition of a new hood to the series 20 miniature hexagonal connector line of Continental precision connectors, terminal boards and stand-off terminals. The type C38-C hood, molded from melamine with aluminum anodized cable clamp is now an added feature to the C5, 7, and 9 contact hexagonal connectors. It provides for strain relief on cable assemblies when disengaging connectors in hard-to-get-at places.

Sharp-Cutoff Pentode

RADIO CORP. OF AMERICA, Harrison, N. J. The 5654 is a "premium" version of the miniature sharp-cutoff pentode 6AK5 for use as a broadband r-f or i-f amplifier in mobile and aircraft receivers. Compact structure provides increased mount strength against shock and vibration. A pure-tungsten heater gives long life under conditions of on-off switching. The tube also features high transconductance, low interelectrode capacitances, high input resistance and high signal-to-noise ratio. A recent data sheet gives a complete technical description, in-

TIC-TALKS FEATURE

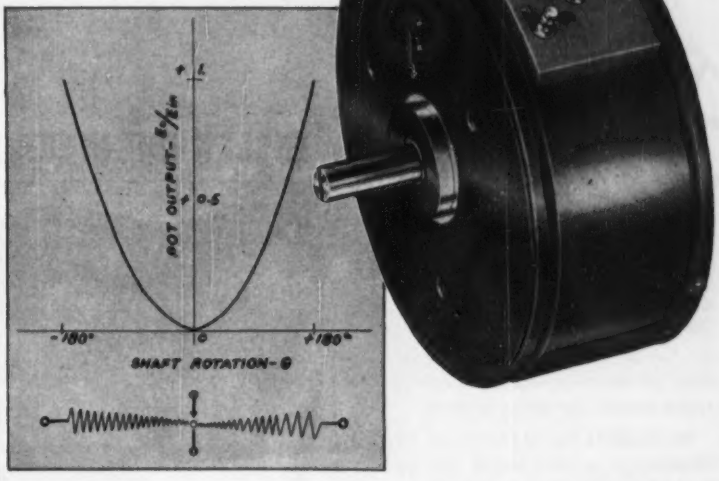
ANALOG COMPUTATION *with* TIC PRECISION POTENTIOMETERS

The type **RVP3-S121** solves the following mathematical equation:

$$\frac{Eo}{Ein} = \left(\frac{\theta}{180}\right)^2, \quad -180° \leqq \theta \leqq +180°$$

SPECIFICATIONS

- Total resistance: 2500 ± 5%
- Conformity to function: ±0.25% Ein
- Function Angle: ±180°
- Mechanical Rotation: 360°
- Dissipation: 2 watts at 25°C.
- Life: 1,000,000 cycles
- Diameter: 3"



Your analog computations in control processes, computers, servomechanisms, and telemetering may likewise be solved by Technology Instrument Corporation precision potentiometers, with ease, economy and extreme accuracy. Precision non-linear potentiometers may be designed to meet your requirements from either implicit functions or empirical data. Submit your problem today for our analysis and recommendations.

A complete line of standard sizes is available, ranging from 7" to ½" in diameter. Greatly expanded facilities plus mass production techniques will meet your volume needs yet maintain precision tolerances in both linear and non-linear potentiometers. Write for catalog for complete information.

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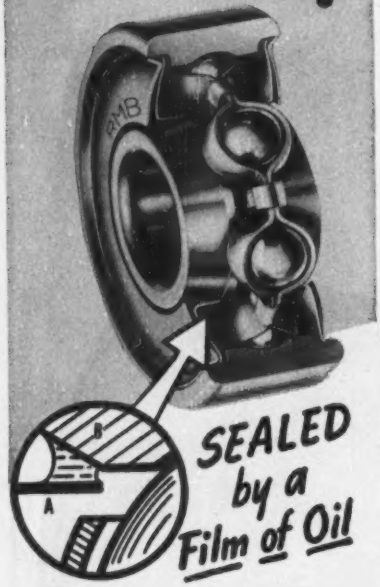
TECHNOLOGY INSTRUMENT CORP.

533 Main Street, Acton, Massachusetts, Phone Acton 3-7711

INSTRUMENT BALL BEARING with a NON-RUBBING SEAL!



SEALED by a Film of Oil

In the new RMB FILMOSEAL bearing, a capillary film of oil forms between cylindrical washer (A) and the tapered O.D. of inner race (B). This strong film of oil seals the bearing — keeps the lubricant in, keeps dirt out — yet there is no rubbing contact between the sealing elements.

The FILMOSEAL bearing thus has all the advantages of a sealed bearing, plus the freedom of rotation of an open bearing:

- Permits the use of oil instead of grease as a lubricant.
- Low starting and running torque.
- Torque constant over long periods.
- Adjusts for pressure variations.
- No heating or scoring at high speed.
- Remains sealed in any position.
- Maintenance is greatly reduced.

FILMOSEAL precision bearings are available in 10 bore sizes from 2 mm. (.0787") to 8 mm. (.3150") and corresponding O.D. from 6 mm. (.2362") to 22 mm. (.8661").

RMB

WRITE FOR COMPLETE DESCRIPTIVE LITERATURE

LANDIS & GYR, INC.
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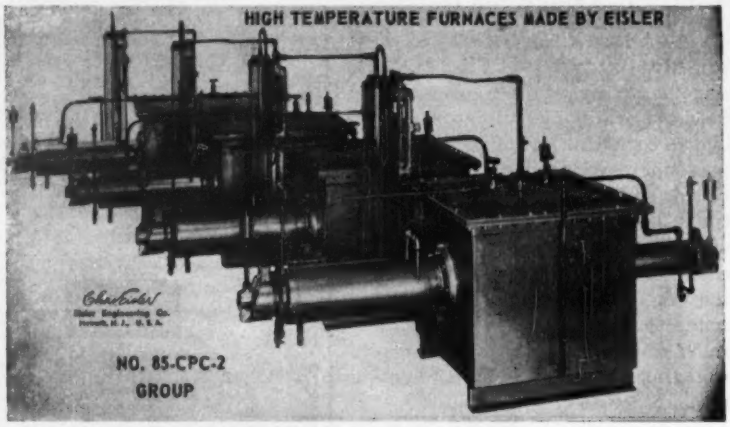
ELECTRONIC GLASS WORKING EQUIPMENT for RADIO, TELEVISION TUBES, INCANDESCENT LAMPS, GLASS LATHES for TELEVISION TUBES

We make Transformers, Spot and Wire Butt Welders, Wire Cutting Machines and 500 other items, indispensable in your production. Eisler Engineers are constantly developing New Equipment. If you prefer your own designs, let us build them for you. Write to Charles Eisler who has served The Industry over 32 years.

Machines for small Radio Tubes of all kinds:

High Temperature Hydrogen Electric Furnaces

Hydrogen atmosphere heating chamber, hydrogen drying tower, water cooled unloading chamber, heat control with air cooled transformer with 11 position tap switch. Automatic temperature control (optional) standard furnaces from 1" bore 1800° C. to 8" bore 1100° C. Molybdenum wound heating units, loading and unloading chambers equipped with safety doors. Supplied with hydrogen flow gauges. Made to order in many sizes.



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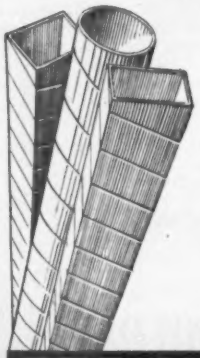
PRECISION PAPER TUBES



Made of the finest dielectric kraft, fish paper, acetate, or combinations, PRECISION Paper Tubes are die-formed under heat and pressure. Uniformity, strength, and light weight are assured. High manufacturing standards and rigid testing result in maximum insulation, heat dissipation, and moisture resistant characteristics.

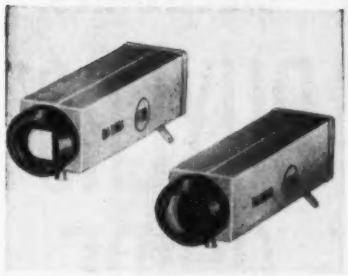
Available in any shape, length, I.D. or O.D. Finished to your exact specifications.

Send today for free sample and request new Arbor List of over 1500 sizes.

PRECISION PAPER TUBE CO.

2041 W. Charleston St. Plant No. Two, 79 Chapel St., Hartford, Conn. Chicago 47, Ill.
Also Mfrs. of Precision Coil Bobbins

cluding characteristics charts and dimensional diagram.



Magnetic Signal

FEDERAL TELEPHONE AND RADIO CORP., Clifton, N. J., has developed a new magnetic switchboard signal capable of providing both visual and audible indication. Designed for fast indication, long life and dependable performance under rugged conditions, this sturdy, compact magnetic unit supplants the mechanical operation common to the old-type drop signal. It is only ¾ in. sq x 3½ in. long, and operates on 8 ma d-c or 8 ma a-c in series with selenium rectifier equipment or its equivalent. The unit is equipped with a contact for an audible signal when required. The new signal is dust and moisture proof, nonpositional and constructed to withstand severe vibration. It has high sensitivity, a luminous face indicator that is clearly visible day or night, and the signal is mechanically restored.

L-V Power Supply

OWEN LABORATORIES, 9130 Orion Ave., San Fernando, Calif. The type 200 low-voltage power supply is a highly regulated unit for use with resistance strain-gage elements, and for similar exacting applications. Output is one ampere maxi-

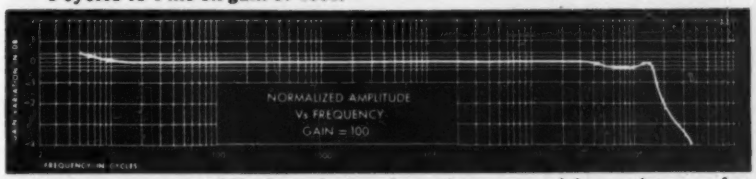
Technology Instrument Corp. Presents a Compactly-Built Wide-Band Decade Amplifier

Featured by its wide band response, high input impedance, low output impedance, and compact dimensions, TIC's Type 500-A wide band decade amplifier is excellent as a general purpose laboratory instrument. Here is an instrument for special applications requiring a zero phase shift and high stability of gain. TIC increases the general utility of this amplifier by including a self-contained power supply and cabinet or rack mounting.

SPECIFICATIONS:

Amplification: 10, 100 and 1000 times, selected by 3-position rotary switch.

Frequency Response: Flat to ± .5 db from 5 cycles to 2 mc on gain of 10; Flat to ± .5 db from 5 cycles to 1.5 mc on gain of 100; Flat to ± .8 db from 5 cycles to 1 mc on gain of 1000.



Amplification Accuracy: ± 2% of nominal — dependent on precision resistors only; Unaffected by normal tube characteristics or line variations.

Phase Shift on All Ranges: 0 to ± 2° from 20 cycles through 100 kc

Gain Stability on All Ranges: Constant with line voltages of 105 to 124 volts.

Noise and Hum: 60 db below maximum output voltage with input shorted.

Input Impedance: Approximately 160 megohms shunted by 7 $\mu\mu f$.

Output Impedance: Approximately 200 ohms.

Output Voltage on All Ranges: 20 volts maximum output across a load of 20 kΩ or greater.

Power Supply: 105-125 volts, 50-60 cycles self-contained power supply requiring approx. 30 watts. (230 volt, 50-60 cycles models available).

Mounting Dimensions: Single, in cabinet: 13¼" wide x 5" high x 9⅜" deep. (11¼" x 3½" panel) Single, for rack: 19" wide x 3½" high x 8½" deep.

The low distortion is a feature much desired in amplifiers of this type.

Further information and details gladly sent upon request.

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TRANSISTORS

In line with our specialization in wire for new applications, we produce wires of composition suitable for the manufacture of Transistors; including GALLIUM GOLD and ANTIMONY GOLD. These alloys have been made to fill a specific need arising from new developments in this field.

Other wires we make regularly for similar application are PHOSPHOR BRONZE, bare or electroplated, and PLATINUM Alloys produced to meet rigid specifications of tensile strength, size and straightness.

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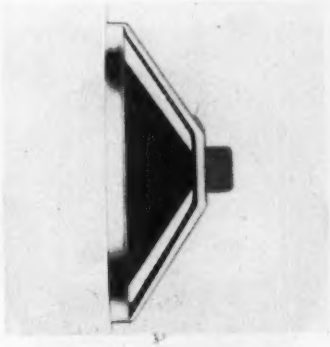
mum, at from 0 to 15 v d-c Where absolute freedom from drift is required a small chopper-amplifier provides precise stabilization against an external reference. The supply may be rack mounted.



Streamlined Speaker

CARBONNEAU INDUSTRIES, 21 Ionia N. W., Grand Rapids, Mich. The Gold Cup speaker features the ultimate in simplicity of design, thus eliminating costly bulk and weight. Ten-inch Gold Cups are now available with 2.15 oz magnet, 1-in. voice coil, and 1.00 oz magnets with 1-in. voice coil, both supplying flux in the air gap equivalent to speakers using up to 50 percent more magnet.

Strip-Wound Transformer Cores

PERMOFLUX CORP., 4900 West Grand Ave., Chicago 39, Ill., announces the availability of its new Cee-Cor strip-wound transformer cores, manufactured from grain-oriented silicon steel strip to exacting mechanical and electrical tolerances. These units give the transformer engineer cores of extremely high efficiency and permeability and are particularly suited to designs where space and weight are critical fact-

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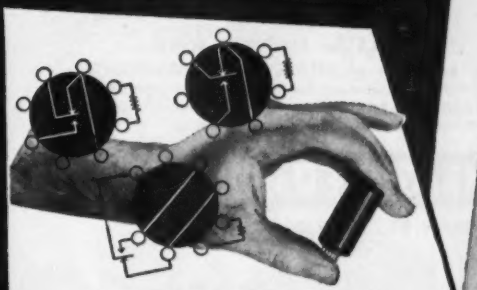
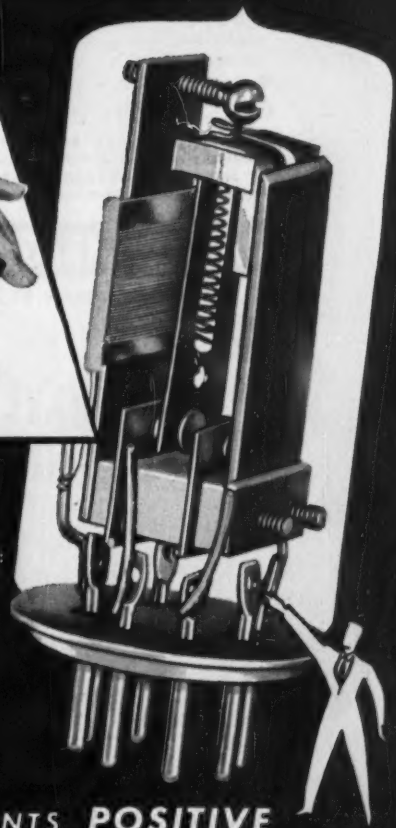
Reduce your problems with the NEW EUREKA "SNAPPER"

THERMAL TIME DELAY RELAY

Features . . . Snap action. Single Pole Double Throw. Lightweight. Low operating temperature. Operates in any position. High contact rating. Gas filled. Low heater current. Durability and long life.



EUREKA'S "SNAPPER"



VOLTAGE: 6.3, 26.5
115 volts (A.C. or D.C.)
or as required

AMBIENT TEMPERATURE RANGE:
−60 C. to + 80 C.

ENVELOPE: Miniature,
or octal metal.

TIME DELAY PERIODS:
Preset from 5 seconds up.

VACUUM: Evacuated, inert gas filled.

HEIGHT: 1¾" maximum seated.

EUREKA PRESENTS **POSITIVE**

SNAP ACTION

The ELIMINATION OF CHATTERING is accomplished with the incorporation of "POSITIVE SNAP ACTION" in the EUREKA "SNAPPER" . . . LEADING ELECTRONIC MANUFACTURERS have acknowledged the new EUREKA "SNAPPER" as a major advancement in this field, and have already accepted this relay as a standard component of their latest equipment.

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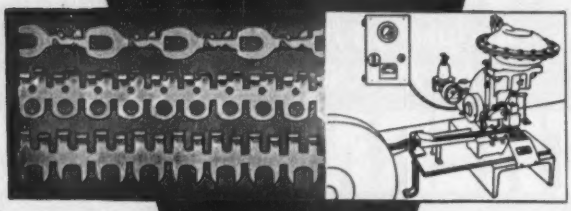
Attached and Soldered



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- RF pads or attenuators
- Dummy loads
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- Impedance matching

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Temperature Coefficient: approx. 0.0019 ohms/ohm/°C.
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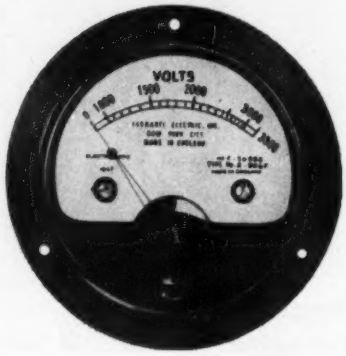

This instrument permits voltage readings on AC or DC circuits of very high resistance. The only current drawn is the very small leakage current and a very low capacitance current on AC circuits. Very useful for the many high voltage—low current circuits employed in nuclear research. Available with full scale voltages ranging between 300 and 3500 volts. Special laboratory instrument available with full scale reading of 150 volts. Full scale capacitance ranges from 8 mmfds for the 3500 volt model to 100 mmfds for the 150 volt instrument. Magnetic damping. 2½" dial. Write for complete specifications.

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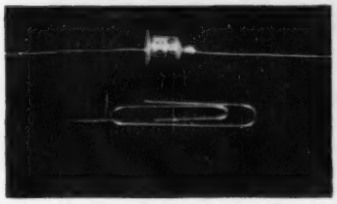
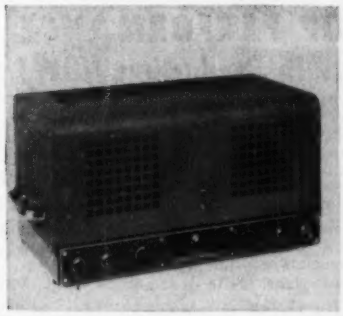


Germanium Rectifiers

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced new diffused junction germanium rectifiers for use in computers, magnetic amplifiers, tv receivers and telephone switchboards. The four models in the new series are hermetically sealed and extremely small in size. Forward resistance of the new units is very low, less than 2 ohms at rated load. Back resistance and peak inverse voltages are high. Peak inverse voltages range from 100 to 400 v. The d-c output currents into a resistive load range from 75 to 500 ma. Full load voltage drop is 0.5 in three models and 0.7 in the fourth. All ratings are at ambient temperature up to 55 C.



Audio Amplifier

SUMMIT ELECTRONICS, INC., 7 Industrial Place, Summit, N. J. A new precision audio amplifier combines unusually low signal-to-noise and distortion factors with high power output. The equipment is available in several models for vary-

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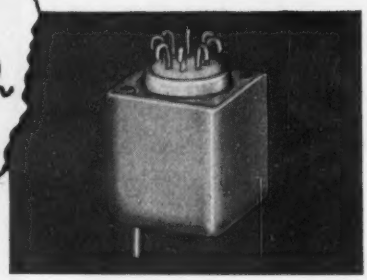

EXAMPLE: Working with the North Electric Manufacturing Co., Galion, Ohio, we developed a new miniature hermetically sealed relay to meet exacting military requirements. Features include an 8-terminal sealed header .600" O.D. and a new design balanced armature relay, sealed in a ¾" x ¾" x ¾" drawn aluminum can. The entire unit may be panel mounted from either the top or bottom. The unit can be furnished either with a dry air fill or vacuum-pumped and pressure filled with dry nitrogen.

HAVING HEADER TROUBLES? We make all types of Sealed Headers, ranging from simple 2- and 3-electrode, crystal holder bases, and standard octal headers, to 14- and 16-terminal headers for sealed Transformer and Relay applications. (Also a variety of special-design headers and terminals.) Write for catalog and quotes.

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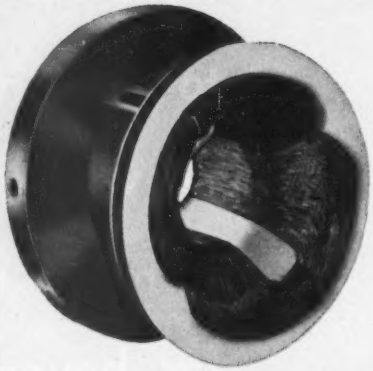
DX Announces a NEW 90° YOKE for 27" TUBES



It's Engineered for TOP PERFORMANCE ... in Production *NOW!*

This new DX 90° Deflection Yoke has everything a television receiver manufacturer wants . . . a sharp full-screen focus, a minimum of pincushioning, the ultimate in compactness and a price that's downright attractive. Because this yoke has been brilliantly designed for mass production on DX's specialized equipment, it warrants immediate consideration in your 27" receiver plans. Write us today.

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DX COMPONENTS
"the heart of a good television receiver"

ing input impedance requirements, while output impedance is switch controlled from 4 to 600 ohms in all models. Employing negative feedback on all stages, the new amplifier offers extremely stable characteristics. Distortion is less than 1.0 percent at the full rated output of 30 w while frequency response is exceptionally flat over a 30-cps to 15-kc range; with a high impedance input the response is flat ±0.2 db over the entire range, and similarly low variances are encountered when low bridging or terminating impedances are used. All components have been carefully chosen to assure fulfillment of the flat frequency response, low distortion and noise characteristics for which the amplifier was designed.

Bandwidth Compressor

HALLER, RAYMOND AND BROWN, INC., State College, Pa. The Rafax bandwidth compressor is a device for laboratory use in connection with testing radar relay equipment and processes. It accepts radar video signals from a search type radar. These signals usually have a bandwidth of from 1 to 5 mc. Its output is a compressed video signal whose bandwidth is of the order of 1 to 5 kc. The device takes advantage of the inherent redundancy in radar signals and of the fact that the usual ppi type radar picture can be reproduced at a bandwidth of only a few kc. Since the Rafax unit should be matched to the parent radar, each application calls for a

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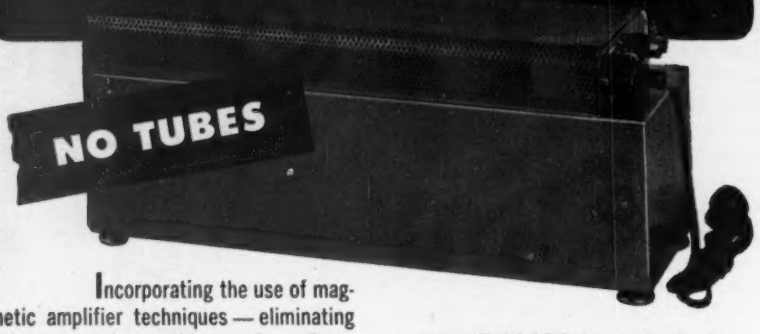

Incorporating the use of magnetic amplifier techniques — eliminating all vacuum tubes — this new Acme Regulated Power Supply provides an extremely dependable, trouble-free precision unit for both industrial and laboratory use. Because of the absence of all tubes, the equipment will give a **minimum** of 20,000 hours continuous service. It is available in a variety of voltages and frequencies.

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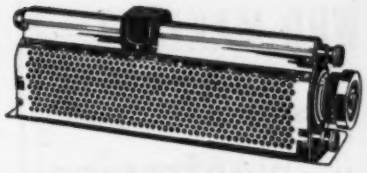
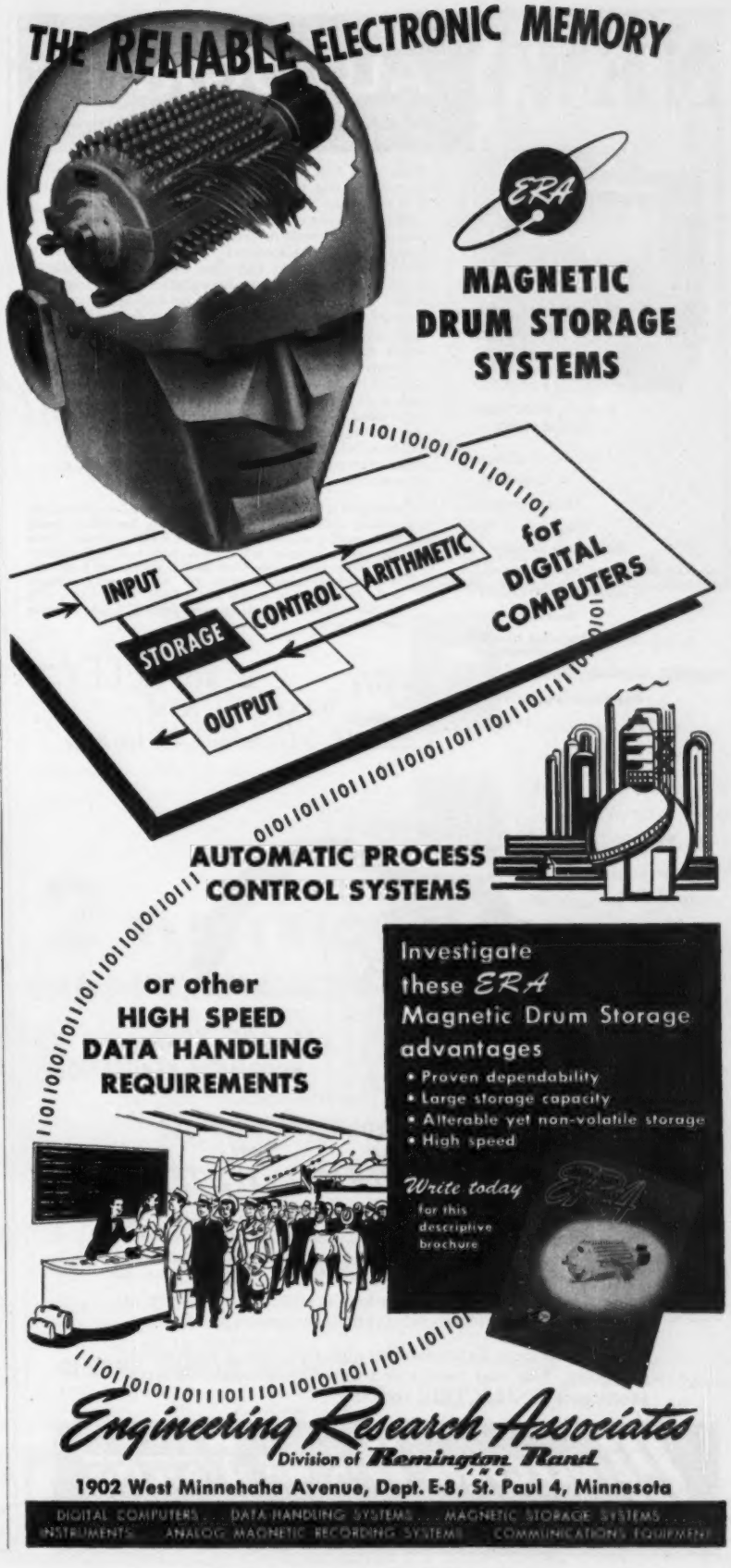


Combination Rheostat

REX RHEOSTAT CO., 3 Foxhurst Road, Baldwin, L. I., N. Y., has introduced a new vernier rheostat for extremely fine control of current and voltage. It consists of a combination of a standard tubular rheostat with a turnable vernier rheostat in series or in parallel connection. Each step on the vernier has about $\frac{1}{10}$th of the ohmic value of one winding of the main rheostat. Each rheostat is provided with a dial, making exact settings of the slider positions possible. Ask for catalog No. 5.

Half-Wave Rectifier

GENERAL ELECTRIC CO., 1 River Road, Schenectady 5, N. Y., has added to its industrial tube line a half-wave rectifier designed for use in h-v rectifier circuits. The type GL-4B32 is designed particularly for use as a rectifier in radio and tv transmitters, industrial heating oscillators, and other applications where high-voltage d-c is required. The tube is an inert-gas-filled tube that will operate over a wide temperature range, from −55 to +70 C. Use of an inert gas instead of mercury permits mounting it in any position. Maximum ratings for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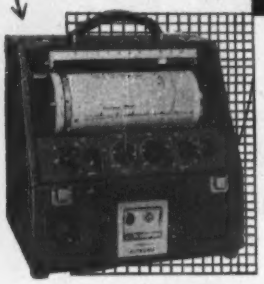

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SPECIFICATIONS: – Two independent servo-actuated recording axes; input free of ground. • Recording speed, both axes, 1 second for full scale travel. • Scales: from 0-5 millivolts up to 0-100 volts, both axes. • Full-range zero set on either axis – plots data in any desired quadrant. • Sensitivity – 200,000 ohms per volt, 5 microamperes drain for full scale. • Size and weight: 13" x 13" x 10"; 35 lbs. • Self-contained; operates from 115 volt 60 cycle line, 85 watts.

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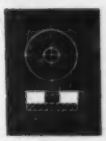

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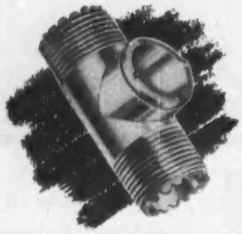

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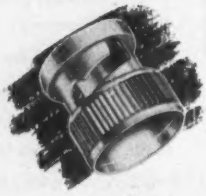

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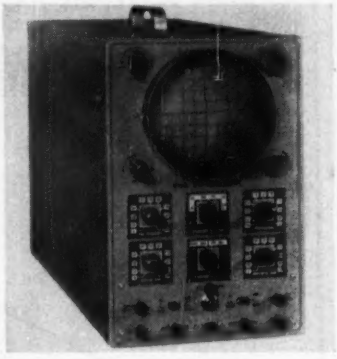
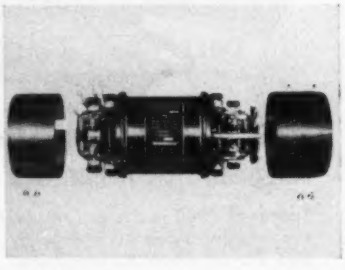
M-W Laboratories, Inc.
1824 N. Milwaukee Ave.
Chicago 47, Illinois

the GL-4B32 include a peak maximum cathode current of 5 amperes, an average maximum cathode current of 1.25 amperes, and a maximum peak inverse anode voltage of 10,000 v. The tube is recommended for use with a filament voltage of 5 v and a filament current of 7.5 amperes.



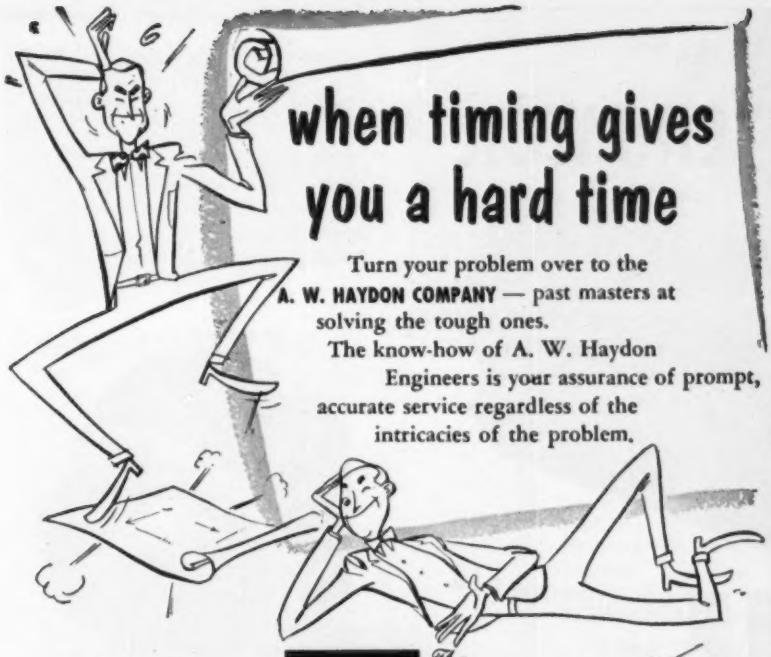
Oscilloscope

ELECTRONIC MEASUREMENTS CORP., New York, N. Y. Model 600 oscilloscope features the use of a 5VPI new 5-in. scope tube. The vertical amplifier has a wide band and can be used up to 5 mc. A two step attenuator input is available. Synchronization is available on either positive or negative phase of input voltage through the vertical amplifier or from an external source. A multivibrator type of sweep from 15 cycles to 75 kc is incorporated.



Dynamotor

ELECTRO ENGINEERING PRODUCTS Co., 609 W. Lake St., Chicago, Ill. Model ES-129 dynamotor is a 4-commutator unit that will operate with equally efficient performance from 6, 12 or 24-v power supply. Output is 500 v at 0.100



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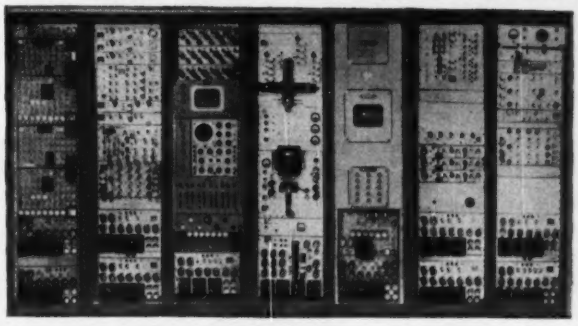

A comprehensive integrated system for transmitting and monitoring self-created as well as remote-origin signals.

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RACK #2 — Gamma Amplifiers, color encoders to convert color signals to requirements of specific system under examination.

RACK #3 — Distribution, monitoring, and switching panels.

RACK #4 — Contains universal color picture generator with crossed dichroic mirror assembly and scanner tube.

RACK #5 — Universal color monitor with dichroic unit.

RACK #6 — Contains off-the-air T.V. receiver, color bar generator, and three video amplifiers.

RACK #7 — Picture (and sound) signal source closely approximating the proper characteristics of T.V. station transmitters; this rack contains also decoders for both NTSC and field sequential rates.

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This outstanding "*Standard*" V.H.F. Attenuator now in its second year of production remains the first and only accurate instrument of its kind and continues to meet a heavy demand from leading organisations and authorities the world over.

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Characteristic Impedance	75 ohms	50 ohms
0-9 db in 1 db steps	Type 74600-A	Type 74600-E
0-90 db in 10 db steps	Type 74600-B	Type 74600-F

All types will handle inputs up to 0.25 watts.

Accuracy of D.C. adjustment

0-9 db Models: The insertion loss error will not exceed ±0.05 db for any setting.

0-90 db Models The insertion loss error for the 90 db setting will not exceed ±0.3 db. For other settings this limit falls linearly to a value of ±0.06 db at the 10 db setting.

High frequency performance

0-9 db Models: At 50 Mc/s the insertion loss error for the 9 db setting will not exceed ±0.15 db. For other settings this limit falls linearly to a value of ±0.05 db for the 1 db setting.

0-90 db Models: At 50 Mc/s the insertion loss error will not exceed ±0.1 db per step. N.B. All insertion loss errors are relative to zero db setting.

Ready for Building into your own equipment. Calibration charts for frequencies up to 100 Mc/s for the 0-9 db models or 65 Mc/s for the 0-90 db models can be supplied on request.

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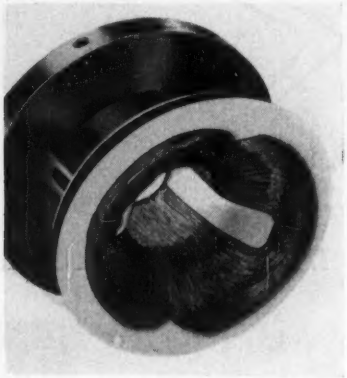
(An I.T & T. Associate)

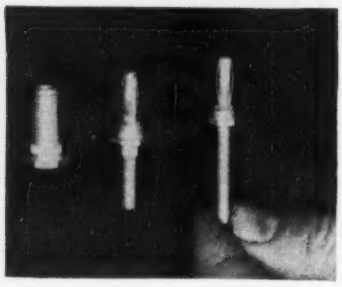
TRANSMISSION DIVISION, NORTH WOOLWICH, LONDON, E16

ampere. Length of the unit is 10¼ in. and diameter is 4½ in. Total weight is 11½ lb. The dynamotor is intended for continuous service, with a rated temperature rise of 50 C. It is ideal for heavy-duty or standard use in communications, laboratory applications, and wherever power supply is variable.



Deflection Yoke

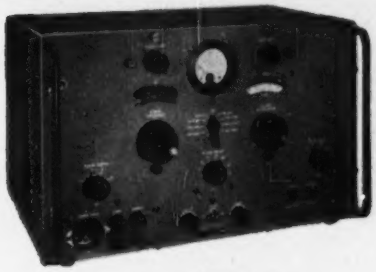
DX RADIO PRODUCTS CO., 2300 West Armitage Ave., Chicago 47, Ill., announces that it is in production on a newly designed 90-deg deflection yoke for 27-in. television tubes. The yoke provides a sharp focus across the entire picture tube screen. The horizontal inductance is 11.2 millihenries and the vertical inductance is 45 millihenries.



Banana Plugs and Jacks

INSULINE CORP. OF AMERICA, 3602 35th Ave., Long Island City 1, N. Y., has announced a new line of silver-plated banana plugs and jacks, intended for use in military, industrial and commercial equipment requiring very low contact resistance. The No. 428 plug has a straight threaded shank 1¼ in. long. The No. 429 has a combina-

Accurate • Portable • AVAILABLE



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900-2100 Megacycles

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Gold Plating of the oscillator cavity and tuning plunger assures smooth action and reliable performance over long periods. Generous use of silicone-treated ceramic insulation, including resistor and capacitor terminal boards, and the use of sealed capacitors, transformers, and chokes, insures operation under conditions of high humidity for long periods.

Built to Navy specifications for research and production testing, the unit is equal to military TS-419/U. It is in production and available for delivery.

Price: $1,950 net, f.o.b. Boonton, N. J.

Type H-14 Signal Generator

(108 to 132 megacycles) for testing OMNI receivers on bench or ramp. Checks on: 24 OMNI courses, left-center-right on 90/150 cps localizer, left-center-right on phase localizer, Omni course sensitivity, operation of TO-FROM meter, operation of flag alarms.

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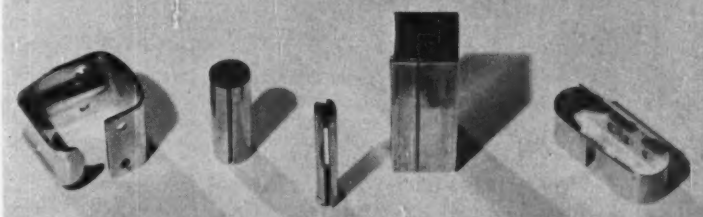

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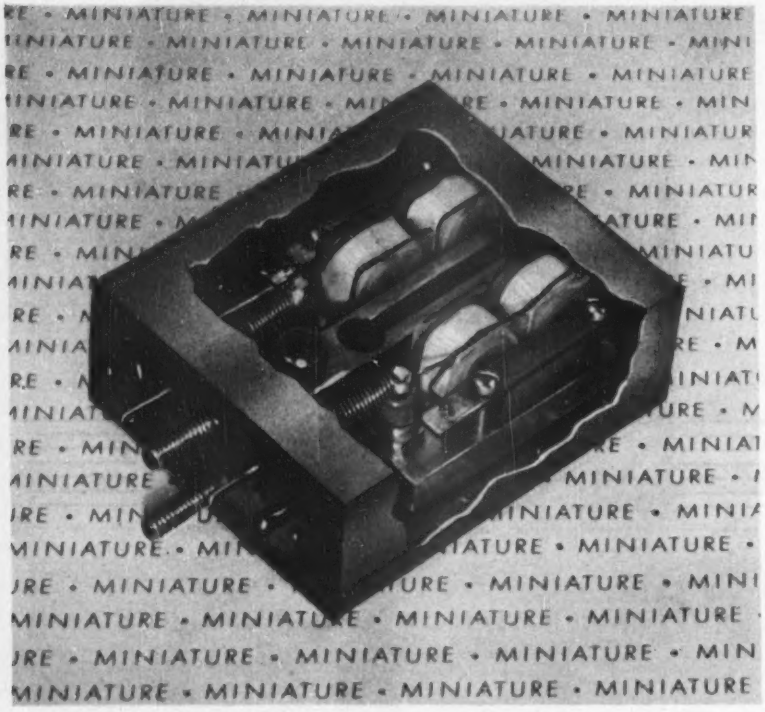

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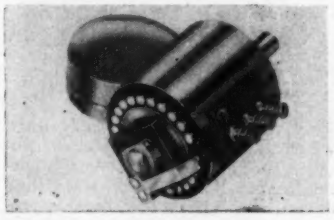
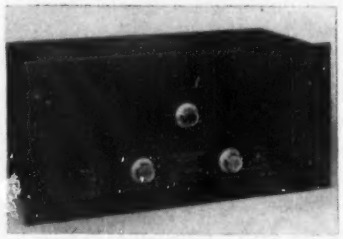
tion shank ¾ in. long with a knurled collar for force-fit in a panel hole and a threaded section in addition. Both plugs have contact springs of beryllium copper. The No. 431 banana jack is machined of solid brass, also heavily silver-plated. It has a knurled shoulder and a threaded body. The hex head is ⅞ in. across flats, and the shank is 3.4 in. long.



Miniature Attenuator

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., has available the series 120 miniature attenuator that is 1⅜ in. in diameter x 1 11/32 in. deep. The unit was developed primarily for government and commercial applications requiring a smaller step-type attenuator. Its reduced size and weight make it particularly suitable for use in portable equipment as well as stationary equipment where space is at a premium. This miniature attenuator is available in 20 steps having a ladder or potentiometer network. All standard decibel steps and various impedances up to 500,000 ohms are available. Resistor accuracy is ±5.0 percent and power dissipation is 0.6 watt.



ULF Oscillator

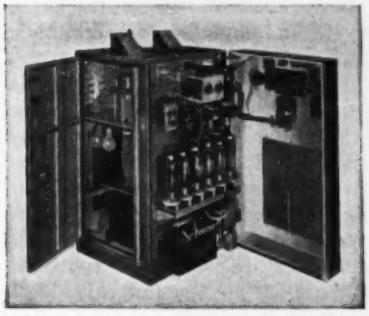
KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39, Mass., announces a new ultra-low-

(Advertisement)

PANELS, LIDS, DOORS MADE RF-TIGHT BY LOW COST METHOD

Electronic Weatherstripping, made of knitted wire mesh compressed to required sizes and shapes, effectively "shields" these openings against RF leakage just as weatherstrips seal doors and windows.

Openings such as these are necessary for operating and servicing the electronic equipment housed in the metal cabinet. Yet these same openings destroy the full shielding efficiency which an "unbroken" metal container would otherwise provide. Careful machining of mating surfaces at



"Thermatron built by Radio Receptor Co., Inc."

these openings is an obvious answer. But such work is expensive, and the initial close fit is often destroyed by repeated openings and closings, by warping of the lid or door and by corrosion of the mating surfaces. Numerous latches, screws, bolts and other fasteners, closely spaced, will help keep these joints RF tight, but they are a time consuming nuisance whenever the cabinet must be opened and closed, and they are expensive to purchase and install.

Metex Electronic strips and gaskets eliminate these objections. Being made of metal, they are conductive; and being knitted they are resilient and conform to normal surface irregularities. They actually "block" the otherwise leaky openings with a gasket of flexible metal, and make the cabinet as effective a conductive shield as if the openings had never been made.

Metex electronic strips and gaskets are easy to install. Not only are they inexpensive, but their use may well save more than their cost by eliminating many operations that would otherwise be necessary. They are available in different shapes, dimensions and resiliencies to meet the varied requirements of specific electronic applications and can be made of metals or alloys selected to meet actual or anticipated corrosive conditions.

A bulletin giving detailed information is available on request from the manufacturer, Metal Textile Corporation, 641 East First Avenue, Roselle, N. J.

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SPECIFICATIONS

- CUT-OFF RANGE — 20 cps to 200 KC
- SECTIONS — 2—can be high, low and band pass
- ATTENUATIONS — 36 db/octave maximum
- INSERTION LOSS . 0 db
- NOISE LEVEL — 80 db below 1 volt
- FREQUENCY RESPONSE — 2 cps to 4 MC

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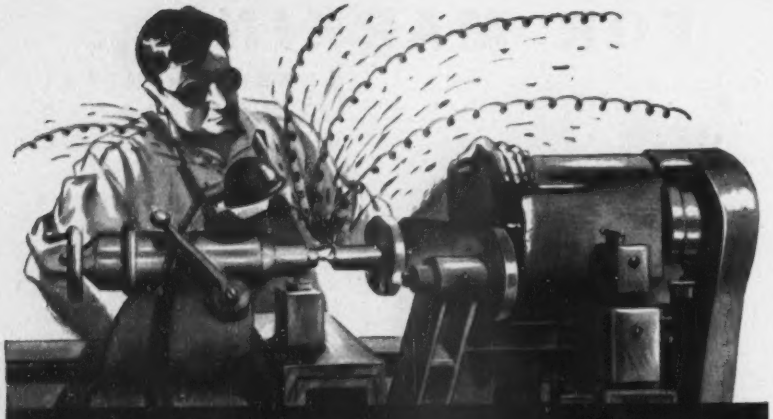

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Our technical catalog describes some of the precision Transicoil units which enable you to take full advantage of your servo system designs. Write for a copy today.

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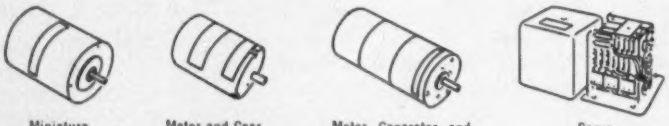


Miniature Control Motors | Motor and Gear Train Assemblies | Motor, Generator, and Gear Train Combinations | Servo Amplifiers

frequency oscillator, model 400 C, with standard rack panel construction. It simultaneously provides both sine and square-wave voltages at any frequency between 0.009 and 1,100 cps. The sine wave output may be used either balanced or single ended. Maximum output is 30 v peak-to-peak across a 1,000-ohm load. Special circuitry to eliminate tuning and band-switching transients has been incorporated. Other features are low hum and distortion, excellent amplitude constancy over the entire frequency range, a single scale logarithmic dial with a vernier tuning control, and low input power. The unit is especially useful for the designing and testing of servomechanisms for geophysical and seismological instruments and feedback amplifiers, for vibration checks and medical research and in conjunction with timing and production controls. Dimensions of the unit are 19 x 8¾ x 7½ in.

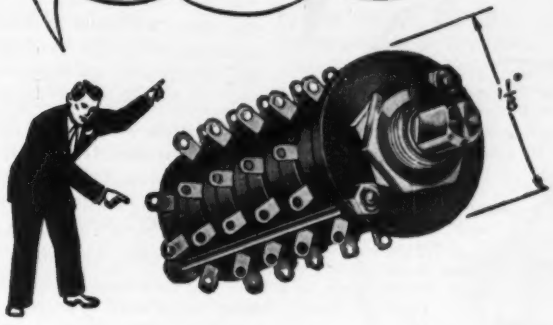
Literature

Permanent-Magnet Motors. Barber-Colman Co., Rockford, Ill., has available p-m motors with electrically balanced armature that insures low radio noise level, higher efficiency, and longer brush life. Ask for bulletin F4344.

Metalized - Power Capacitors. Aerovox Corp., New Bedford, Mass. Concise, yet highly informative, is the "High-Temperature Metallized-Paper Capacitors" bulletin now available. It deals with the performance characteristics of such capacitors, including facts, figures and graphs on rated voltages, temperature range, insulation resistance, nominal capacitance, power factor, vibration, humidity and life test. It also gives available types and listings.

Gas Tubes in Industry. Electrons, Inc., 127 Sussex Ave., Newark 4, N. J. A treatise on the history, development and application of hot cathode gas-filled rectifier and thyratron tubes has just been pub-

THE GRAYHILL SERIES 5000 MINIATURE TAP SWITCH IS DESIGNED TO MEET SPACE FACTORS INVOLVED IN THE MINIATURIZATION TREND. THE POSSIBLE CONTACT ARRANGEMENTS RUN FROM A SINGLE DECK UP TO 10, WITH FROM 2 TO 10 TAPS PER DECK. EITHER SHORTING OR NON-SHORTING CONTACTS. RATED TO BREAK 1 AMP., 115 V. A C, NON-INDUCTIVE.



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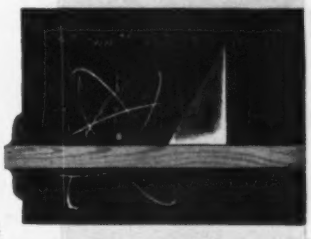

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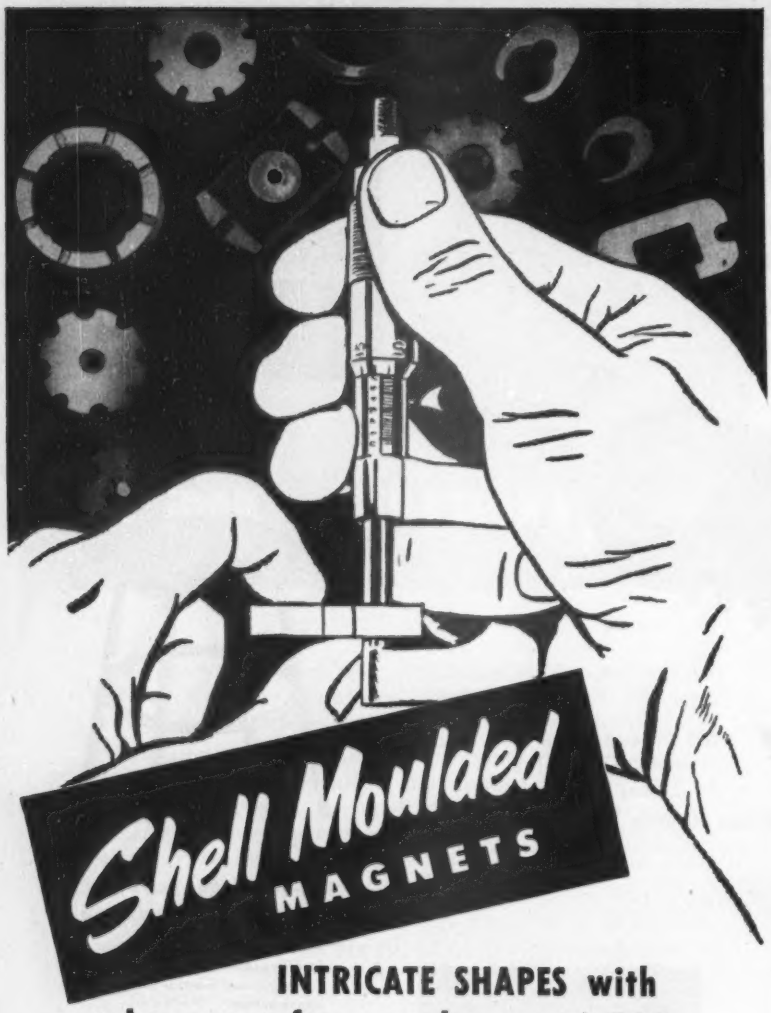

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THOMAS & SKINNER Steel Products Company
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lished. Entitled "Gas Tubes in Industry," the treatise is concisely written, but comprehensive in its coverage of the subject. It will give the reader a well-rounded introduction to the many useful purposes of the EL rectifier and grid control (thyratron) tube.

Parts Catalog. Newark Electric Co., 223 W. Madison St., Chicago 6, Ill., has published a 196-page comprehensive parts catalog containing thousands of items for industry, laboratories, high fidelity, radio and television. Whole sections are devoted to test equipment, industrial equipment and supplies, high-fidelity systems and components, tv chassis, accessories and antennas, including the latest vhf antennas and converters, tape, wire and disk recorders, phonos and changers, p-a and intercom systems, books, tools and the latest in amateur equipment. Wherever possible the complete lines of all nationally-known manufacturers are listed.

Printed Circuits. Electralab, Inc., 105 First St., Cambridge 41, Mass. A recent 8-page catalog contains a picture story showing the company's facilities for engineering and designing printed circuits in addition to the large scale production of this type of assembly. Included is a list of 17 of the many electronic applications that have been engineered by the company utilizing printed circuits and unitization techniques.

Research Laboratories. Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill., has published bulletin R10, a 47-page book containing information on the latest facilities and services of its new Research Laboratories. The book will be of interest to anyone engaged in research, development and instrumentation in the fields of nuclear physics, servomechanisms, upper air research, weather reconnaissance, radar, sonar, guided missiles and general electronics.

Transmission Systems. Fischer & Porter Co., 7250 Jacksonville Road, Hatboro, Pa. Catalog T-50 de-

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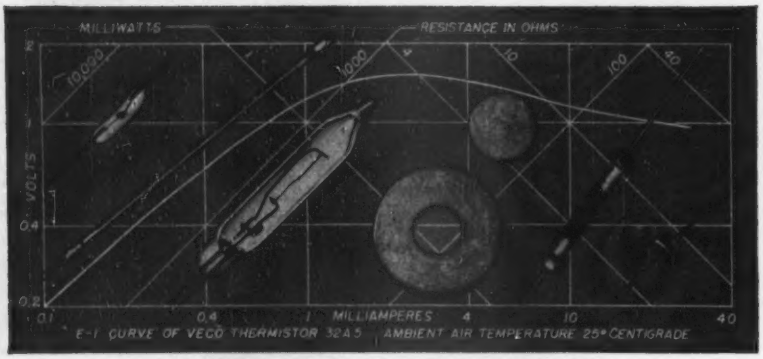

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scribes completely the pneumatic, magnetic, electric, electronic and electronic-follower transmission systems for use in measurement and control of flow, pressure, liquid level, viscosity and specific gravity. The booklet is profusely illustrated containing performance characteristics and schematic diagrams of the various systems.

UHF Booklet. The Brach Mfg. Corp., 200 Central Ave., Newark 4, N. J., has available a booklet entitled "How to Select UHF TV Antennas". The introduction to the booklet outlines the major differences between vhf and uhf and also the different problems that may arise. Example 1 takes into account the primary signal area where there are no reflections. Example 2 describes the primary area with reflections and interference. Example 3 discusses primary areas with both uhf and vhf. Examples 4, 5 and 6 discuss respectively the problems of installation that arise in primary uhf areas with medium vhf signals, fringe areas for uhf only, and indoor reception with uhf. Example 7 outlines the new Mul-Tels designed primarily for uhf multiple installation systems.

General Catalog. Thordarson-Meissner, Mt. Carmel, Ill. The No. 53-A general catalog includes such new products as a novice transmitter kit and a new high-fidelity 10-w amplifier. The catalog is packed full of information and specifications on the company's line of a-m/f-m tuners, receivers and amplifiers. Included also is a section on receiver and amplifier kits, for those who like to build their own. Many new items have been added to the regular list of coils, chokes and traps.

X-Ray Spectrograph Chart. North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y., has available a new 17½ x 22½ in. x-ray spectrograph chart showing characteristic secondary x-ray beams for elements from sodium (Atomic No. 11) to uranium (Atomic No. 92). The new chart is suitable for wall display and will greatly assist scientific personnel in understand-

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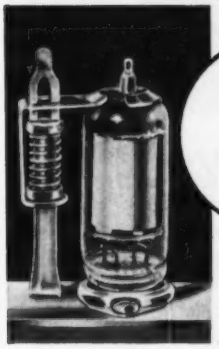

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BIRTCHER TUBE CLAMPS can be used in the most confined spaces of any compact electronic device. Added stray capacity is kept at a minimum. Weight of tube clamp is negligible.

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5/16" DIA. x ¾" LG.

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Complete Frequency Coverage—14kc to 1000 mc!

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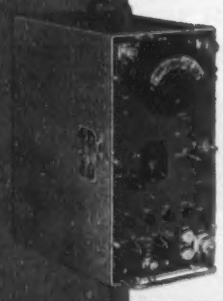
14kc to 250kc

Commercial Equivalent of AN/URM-6B.

Very low frequencies.



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ing the theory and principles of x-ray spectrography and will be useful in handling actual problems. It shows K Alpha and K Beta lines for mica analyzing crystal, for quarts analyzing crystal, for lithium fluoride analyzing crystal and rock salt analyzing crystal. It also shows L Alpha, and L Beta, lines, 1st and 2nd orders, for rock salt analyzing crystal. The horizontal scale on the chart shows 2 Theta Angle in degrees, as well as wavelengths in Angstroms for all elements under various conditions.

Antennas & Accessories. United Catalog Publishers, 110 Lafayette St., New York 13, N. Y., has available a 76-page booklet cataloging radio and tv antenna systems, antennas and accessories, and giving detailed specifications, illustrations, descriptions and prices. It covers the products of the 32 leading manufacturers and includes f-m, a-m and uhf antennas, tv towers, masts, tv boosters, insulators, wire and mounting hardware, among other items.

Germanium Diodes. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, Long Island, N. Y. A single-sheet bulletin announces the addition of a line of seven germanium diodes of the hermetically sealed glass variety which are not affected by atmospheric conditions of humidity, altitude and extremely low temperature. Four of the diodes described are electrically interchangeable with well-known standard types, and the others are new. All are highly resistant to shock and vibration. Characteristics, ratings and curves are included.

Electrometer. Special Instruments Laboratory, Inc., Knoxville, Tenn., has published a single-sheet bulletin illustrating and describing the model 145 electrometer, an a-c operated sensitive d-c amplifier of very high input impedance and excellent stability. The instrument discussed measure voltages of 0 to 150 mv directly on a panel meter, and it may be used to measure currents from 10^{-6} to 10^{-16} amperes either directly or by the slide-back voltage method. The unit described

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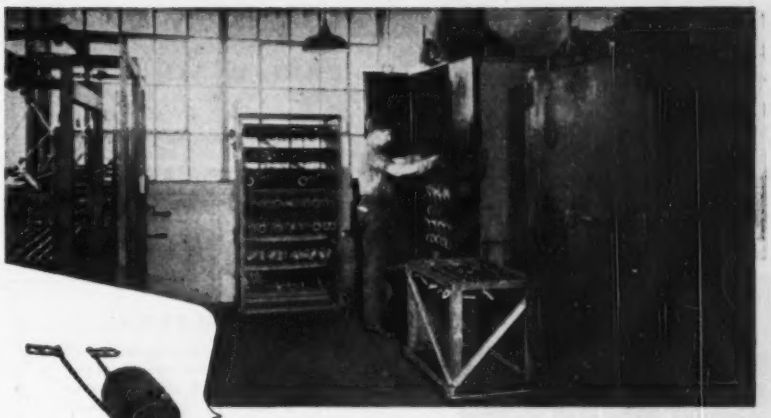

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MODEL 28 STANDARD RACK MOUNTING

PANEL SIZE 5¼" x 19" HEIGHT 14 1/8"

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
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- **RIPPLE OUTPUT:** Less than 10 millivolts rms

For complete information write for Bulletin E

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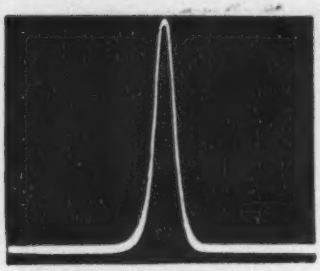
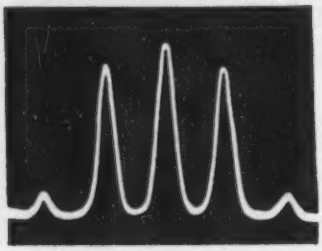
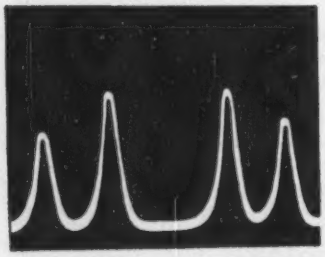


Unmodulated Carrier



Modulation Index 1.3



Modulation Index 2.4
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also measures resistances from 10^5 to 10^{13} ohms. Circuit and operation specifications are included.

TV Replacement Guide. Thordarson-Meissner, Seventh and Bellmont, Mt. Carmel, Ill., has released a new tv replacement guide handbook for the service industry. Complete up-to-the-minute information is arranged alphabetically by manufacturers and their model numbers, for over 2,500 tv models. Manufacturers' parts numbers and the Thordarson-Meissner replacement types are listed for power and filament transformers, filter chokes, audio, vertical and horizontal output transformers, focus coils, booster transformers, horizontal and vertical blocking transformers and deflection yokes. In addition, the guide contains much other information, such as color codes on all kinds of transformers, resistors, capacitors and coils.

Analog Computer. Computer Corp. of America, New York, N. Y., has released a 12-page catalog that gives full product description and specifications of IDA (Integro-Differential Analyzer). The catalog discusses the general theory of analog computers and describes the method of setting up problems for solution. Three pages of typical examples in various fields of dynamics furnish graphical illustration of these principles. Also described is the new NLU-2 function simulator, which makes possible the addition of backlash, dead-zone and limit stops to IDA or any other analog computer.

Cords, Tapes & Sleevings. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill. Cotton, glass and asbestos woven tapes, braided sleevings, and cords for electrical insulating purposes are fully described in a new 28-page catalog. Information on applications, properties, technical data, sizes, types and packaging is included. Products described are used in motors, coils, tv sets, transformers and other electrical units in a variety of ways. As well as covering the Imcor, Electra, Fiberglas, R/M and Asbeston brands of

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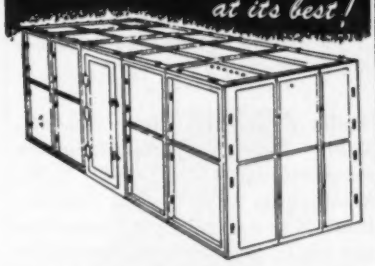

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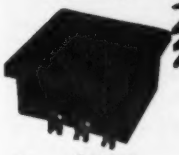

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cords, tapes and sleevings, the catalog explains characteristics of the basic cotton, glass and asbestos fibers.

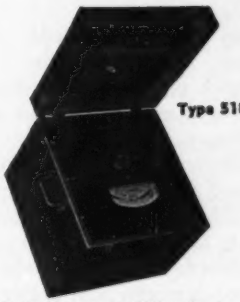
Audio Facilities for Schools. Radio - Television Manufacturers Association 777-14th St. N.W., Washington 5, D. C. The Association's School Equipment Committee has available a new booklet on audio facilities for school use. This booklet, the title of which is "Teaching with Radio, Audio, Recording and Television Equipment," combines and brings up to date material contained in the three former Committee publications and also includes information on the use of tv in public schools. It was prepared with the assistance of a group of educators appointed by the U. S. Office of Education.

Strip Chart Potentiometer. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Aves., Philadelphia 44 Pa. Specification sheet 179 illustrates and gives full details of the new Brown ElectroniK strip chart potentiometer with two-second full scale pen travel for 60-cycle operation. The instrument described has a calibrated accuracy within $\pm\frac{1}{2}$ of 1.0 percent of scale span for spans in excess of 12 mv; within ± 0.045 mv for spans less than 12 mv.

Sound-Powered Communications Equipment. The Wheeler Insulated Wire Co., Division of The Sperry Corp., Waterbury 20, Conn., offers a new file-size comprehensive catalog bulletin covering sound-powered communications equipment for industrial and commercial use. Designated as bulletin SA-25, it includes installation information, wiring and dimension diagrams and description of special instruments.

Microwave Products. Microwave Associates, Inc., 22 Cummington St., Boston 15, Mass., announces the availability of the 8-page catalog 52A. Over eighty products are described, including magnetrons, radar gas-switching tubes, silicon diodes, waveguide components and test equipment for the millimeter

RAWSON ELECTROSTATIC VOLTMETERS



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Measure true R.M.S. values on A.C., no waveform or frequency errors.

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Leakage resistance greater than one million megohms. These meters may be used to measure STATIC ELECTRICITY!

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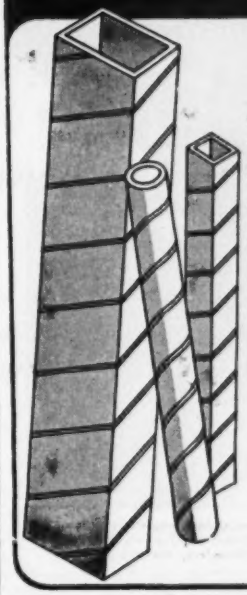

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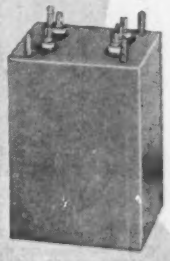

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Photos show complete simulator and internal application of precision potentiometers, courtesy of ERCO

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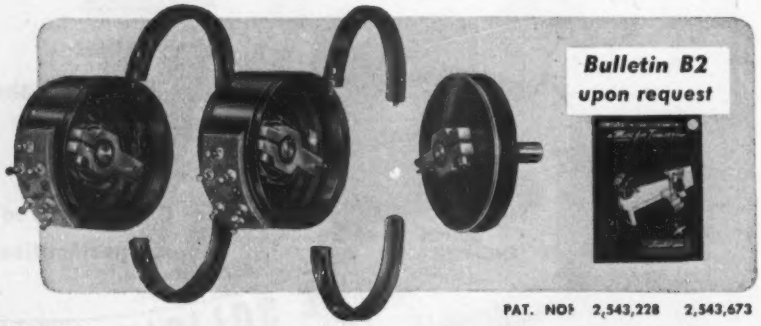

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and centimeter wavelengths. The research and production facilities are also described with numerous illustrations.

Snap Nut Fasteners. Prestole Corp., Toledo, Ohio. Bulletin 8000-A gives complete engineering and application data on snap nut fasteners that have been popular with production personnel as a means of securing front mounting, and/or blind assembly applications with metal screws or studs. The fasteners described allow high speed assembly and prevent "dead-tight" fastening that might craze enameled or painted surfaces.

Small High-Reliability Tubes. General Electric Co., 1 River Road, Schenectady 5, N. Y., has published a new booklet describing the essential characteristics of 17 Five Star miniature and 8 subminiature high reliability tubes. Publication ETD-548A covers tubes designed for use in critical applications, both industrial and military, in which operational dependability is essential to protect life, customer's investment or product reputation. Included in the data are the specific differences between individual Five Star Tubes and their standard-tube prototypes, heater ratings, maximum design center ratings and operating characteristics.

Digital Recorder. Berkeley Scientific, Division of Beckman Instruments Inc., Richmond, Calif., has available a single-sheet, loose-leaf-perforated bulletin dealing with the series 1550 digital recorder that provides a simple, reliable and inexpensive means of converting electronic count information into printed form. Illustrations, description, basic design information, operation data and specifications are included.

High-Current Test Unit. Multi-Corp., Harrison, N. J. Bulletin 1005-111 announces the development of a portable high-current test unit designed primarily for use by electrical utilities and larger industrials. Principal uses of the unit described include testing and calibrating oil circuit reclosers,

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A model for every use.
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These Choppers convert low level DC into pulsating DC or AC so that servo-mechanism error voltages and the output of thermocouples and strain gauges, may be amplified by means of an AC rather than a DC amplifier.

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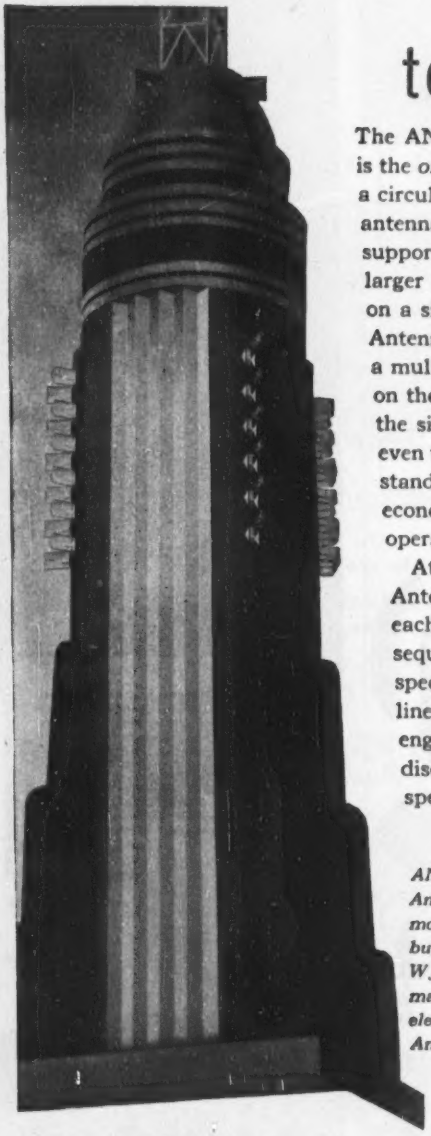
for VHF and UHF

television



The ANDREW "Skew" Antenna is the *only* antenna which provides a circular radiation pattern from antenna elements placed around a supporting structure which is larger than a half wave-length on a side! With the "Skew" Antenna, it is possible to mount a multiplicity of TV antennas on the sides of tall buildings, on the sides of existing towers — even towers which also support a standard antenna on top. The economy offered by a joint operation of this type is obvious.

At present, the "Skew" Antenna is custom built for each installation and consequently general performance specifications cannot be delineated. However, ANDREW engineers will be glad to discuss its application to specific situations.

ANDREW four element "Skew" Antenna on the conical end of the mooring mast of the Empire State building, used as auxiliary by WJZ-TV. Lower on the mooring mast, artist's sketch shows the 48 element ANDREW "Skew" Antenna to be installed for WATV.

*Patents applied for

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TRANSMISSION LINES FOR AM-FM-TV-MICROWAVE • ANTENNAS • DIRECTIONAL ANTENNA EQUIPMENT • ANTENNA TUNING UNITS • TOWER LIGHTING EQUIPMENT

CSP transformer breakers, sectionalizers, circuit breakers, motor overload relays, current transformers, fuse links and overcurrent relays of all types. Also available with the bulletin is a partial list of Multi-Amp users.

Magnetic Amplifiers. Karl-Douglas Associates, 3160 W. El Segundo Blvd., Hawthorne, Calif., have released a brochure describing their line of magnetic amplifiers. The publication describes the six important advantages of magnetic amplifiers over other power control amplifier designs; lists typical performance specifications for 60-cycle and 400-cycle units; and lists the various applications where they can be used.

Printed Circuits. Electralab, Inc., 105 First St., Cambridge 41, Mass. A recent 8-page catalog contains a picture story showing the company's facilities for engineering and designing printed circuits in addition to the large scale production of this type of assembly. Included is a list of 17 of the many electronic applications that have been engineered by the company utilizing printed circuits and unitization techniques.

Servo Amplifiers. Industrial Control Co., Wyandanch, L. I., N. Y., has available a booklet dealing with a line of standard servo amplifiers that lead the way to the quick and facile use of servo systems, and obsolete the development delays and expense otherwise necessary. Truly versatile, with adjustable parameters, the instruments discussed mate with a broad range of gear ratios and load constants. Illustrations, specifications and applications are given for the model 410-A and 423-A servo amplifiers, model 100-A dynamic analyzer, model 204-A null detector, model 200-A d-c millivoltmeter and model 302-A motor control. Also included is a servo data sheet that will enable one to define all his servo performance requirements.

Resistors and Controls. Clarostat Mfg. Co., Inc., Dover, N. H. An exceptionally wide choice of resistors, controls and resistance de-

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Not a gravity dispenser — Forcibly ejects hot waxes and cements.
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Reduces unit costs—No skilled operator required. Saves material — reduces rejects.
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An extremely sensitive amplifier type instrument that serves simultaneously as a voltmeter and high gain amplifier.

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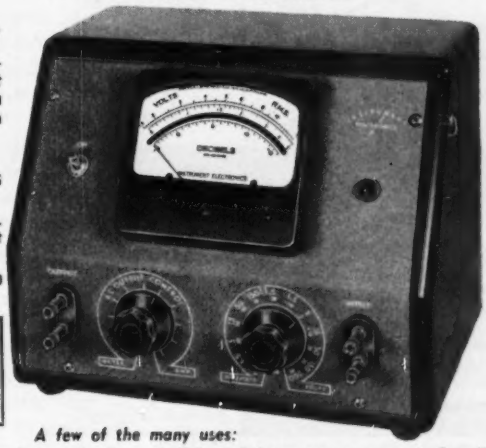

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5 Cycles 1600 kc

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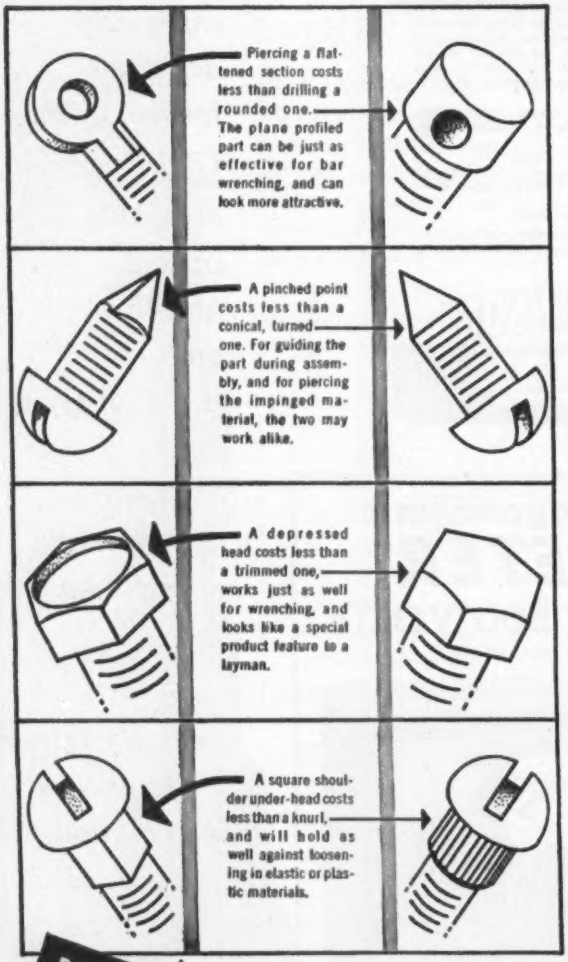
Piercing a flattened section costs less than drilling a rounded one. The plane profiled part can be just as effective for bar wrenching, and can look more attractive.
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REPRINTS *of this chart are available on request for use in drafting and purchasing departments.*

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vices is presented in the latest catalog, No. 52. The catalog features expanded listings of carbon and wire-wound controls, including Pick-A-Shaft or field-inserted-shaft controls taking any one of 12 different shaft types, plus the non-metallic shaft and the high-voltage coupler. For the first time the aircraft-type metal-cased power rheostats are offered, together with miniaturized carbon and wire-wound controls, and the outdoor-theatre L-pad.

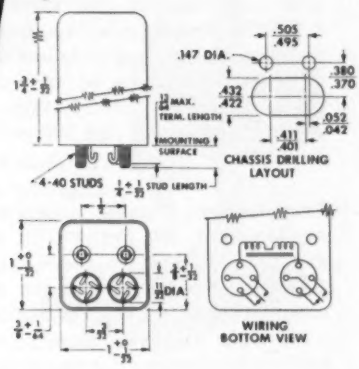
Electrical Embedment Resin. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn. A new industrial technique—embedding electrical components in "Scotchcast" brand electrical insulating resins—is described in an 8-page, illustrated booklet. Applications for both "Scotchcast" resin No. 1 (hot pouring) and "Scotchcast" resin No. 2 (cold pouring) are given, the use of fillers to obtain special characteristics is discussed, and casting techniques are outlined briefly. The outstanding properties of these epoxy "Scotchcast" resins—moisture resistance, dielectric strength, adhesion, low shrinkage and stability over a wide range of temperatures—are presented in detail on a technical data page.

Two-Way Radio. General Electric Co., Syracuse, N. Y. A new 8-page illustrated booklet discusses the use of two-way radio for better coordination of men, materials and machines. The booklet, titled "Instant Communication," is slanted to those businesses using materials handling and emergency service equipments, and others who have plant protection problems. It outlines the use of two-way radio in numerous industries, and shows equipment now available for a wide variety of applications. The new publication also carries a list of 27 GE offices throughout the U. S., from which advisory service is now available on communications problems.

Flexible Cords. Whitney Blake Co., New Haven 14, Conn., has available an illustrated 24-page bulletin that includes all of the new Underwriters' classifications for its flexi-

Phaostron SENSITIVE MINIATURE RELAYS

PERFECTLY COUNTER-BALANCED



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Hermetically Sealed.

Required coil power as low as 20 milliwatts.

Coil resistance up to 15,000 ohms.

Weight, maximum 3.5 oz.

DUE TO ITS PERFECTLY COUNTER-BALANCED FEATURES THIS RELAY WILL WITHSTAND HIGH ACCELERATION, VIBRATION, SHOCK AND TUMBLING

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Electric etching attachment available.

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Kenyon TRANSFORMERS for standard and special applications

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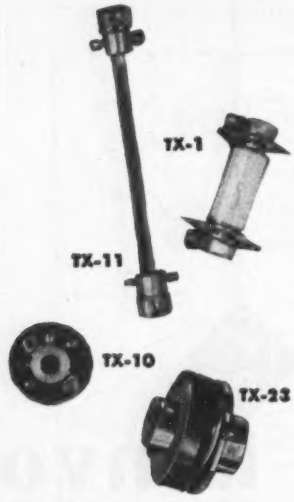
Components



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ble cords. Featuring catalog data on Dynaprene and rubber-jacketed cords as well as braid-covered types, the bulletin also gives information on cord selection, how to order specialties and technical data of interest to users of wire and cable. It includes illustrations of factory operations and laboratory facilities.

Transformer Catalog. Thordarson-Meissner, Mt. Carmel, Ill., has announced its new No. 400-K transformer catalog. It contains unusually complete listings of replacement types of power, filament and audio transformers for the service industry, as well as standard types. A special section is devoted to various types of transformers used in the tv service field. Many special transformers, such as vibrator, isolation and band-pass speech filter types are also listed in the catalog.

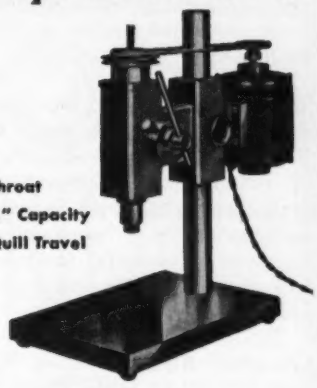
C-R Tube Reflectance Meter. Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md. Bulletin 120 covers the portable Glossmeter for television tube face plates. The instrument discussed is highly versatile and convenient for measuring reflectance from any type of tube face with a radius of curvature greater than 12 in. An illustration, descriptive of the instrument and method of operation, is included.

Embedded Selenium Rectifiers. Sarkes Tarzian, Inc., 415 N. College Ave., Bloomington, Ind., has published a new 4-page folder dealing with embedded selenum rectifiers. (Embedments are designed principally for use where because of environmental conditions or extreme altitudes, standard convection cooled painted rectifiers are not suitable.) Designated as Number B-1, this catalog gives detailed information on the various types of embedments made by the firm. Illustrations and dimensional diagrams are included.

Audio Catalog. Terminal Radio Corp., 85 Cortlandt St., New York 7, N. Y., has published a 132-page audio equipment catalog. Besides fifty pages of high-fidelity home music system components, the book

Precision drilling made easy!

***Phillips & Hiss* 204-C**



6" Throat
0-1/8" Capacity
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Sensitive "Feel"

Sensitive Speed Control: Foot-operated, leaves both hands free

High Precision: Selected Chuck and Bearings. Spindle true within .0002". Table square .0005" in 5" circle. Permanent accuracy, castings annealed and ground.

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FOR STRAIN GAGE APPLICATIONS

THE TYPE 200

This highly regulated d-c supply furnishes one ampere at zero to 15 volts, for the most exacting applications. The output will vary less than .005 volt for 10% line voltage changes. Drift is low, and can be completely eliminated by an accessory plug-in unit which provides chopper stabilization. Write for details.

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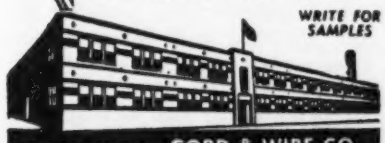

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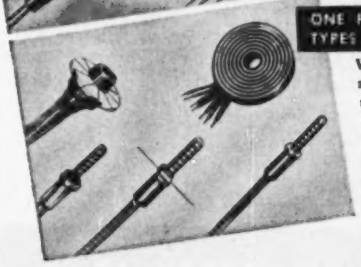
Assemblies of these types can be supplied at low cost. Quality is the highest in the industry. Dimensional accuracy and other characteristics are excellent and these units are highly recommended for instruments such as synchros.



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Wherever extreme dimensional precision, accurate concentricity, and high dielectric qualities are required the electro-deposition method is recommended . . . the production of which is licensed under an exclusive arrangement with the Electro Tec Corporation. This well-known process is most satisfactory for miniatures and sub-miniatures down to .035" diameters.

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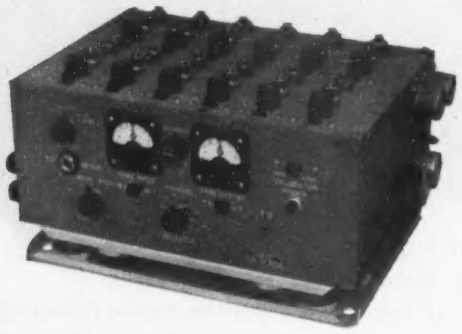
Century MODEL 1809 BRIDGE CONTROL UNIT

FOR VIBRATION AND STRESS ANALYSIS



Designed as a companion unit to Century's famous Model 409 Oscillograph, the Model 1809 Bridge Control Unit is the latest addition to Century's line of industry-standard vibration and stress analyzing equipment. Packaged in a small, compact space, the unit contains all of the facilities necessary for use with 12 channels of resistance strain gages or bridge-type transducers. Where used with the Model 409 Oscillograph, it is necessary only to connect strain gages and power source to have a complete stress-strain measuring and recording system, small and rugged enough to be placed in an aircraft wing tip or guided missile warhead.

FEATURES:

Size: 4½" x 7" x 11".
Weight: 10½ pounds.
Aluminum case.
Up to 12 channels.
For any resistance strain gage or bridge-type transducer.
May be used with direct indicating instrument.
Power: Control unit, 22-28 Volt D.C.
Strain gage, 6-28 Volt D.C.

Write for Bulletin CGC—307

MODEL 409 OSCILLOGRAPH

The Century Model 409 Oscillograph has been designed for recording data where space and weight requirements are limited. The Oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:

Size: 5" x 6 15/16" x 11 15/16".
Weight: 13 pounds.
Cast aluminum case.
Paper speeds variable ½" to 6" and 2" to 24" per second.
Detachable daylight loading magazine with a capacity of 3⅜" x 100' paper.
2 to 14 individual channels.
Trace identification.
Trace viewing.

Write for Bulletin CGC—303

Century GEOPHYSICAL CORPORATION
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illustrates and describes seventy-six pages full of public address, institutional, recording and broadcast equipment as well as audio test instruments and similar specialized equipment.

Shaded Pole Motors. Barber-Colman Co., Rockford, Ill. Motor sheet F 4271-2 describes a complete line of unidirectional, reversible and synchronous shaded pole motors for servomechanisms, communication equipment, industrial instruments and other uses. The publication is available on request.

Retaining Rings. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. The new 52-page retaining ring catalog is packed with engineering specifications, data and other useful information covering 17 different types of Truarc rings and more than 600 different sizes. Designed to help engineers properly select and use the rings to best advantage, the catalog devotes 28 pages to data and charts giving ring dimensions, groove dimensions, clearance, allowable thrust loads, safety rpm limits and countless other valuable data. Six pages graphically illustrate typical cost-cutting applications and at-random field applications covering self-locking ring types, basic ring types, rings for taking up end-play and rings applied radially. Assembly and acessory tools designed to handle retaining rings on a speedy production line basis are illustrated and described in detail.

Wiring and Insulation. The William Brand and Co., Inc., North and Valley Sts., Willimantic, Conn., has released a new wiring and insulation manual entitled "Here's How Turbonics Will Assist You in Solving your Complicated Wiring System and Insulation Problems." The manual explains how to obtain pertinent information required to permit uninterrupted operation of any electrical unit or component from a wiring and insulation point of view. It is intended particularly for all aircraft, design, development engineers who are continuously faced with the trend toward lighter weight, smaller space factor, better

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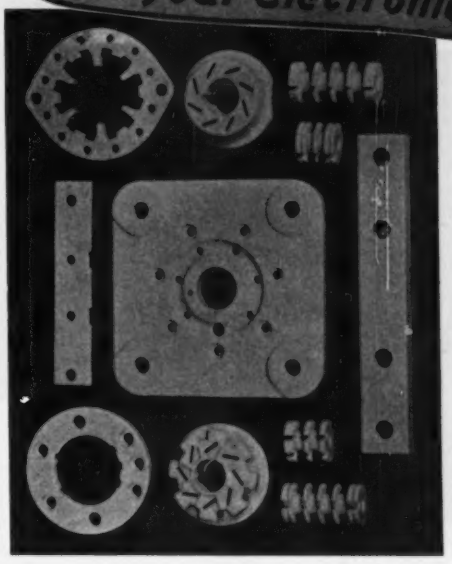

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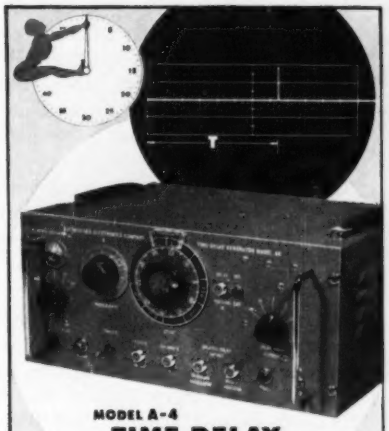

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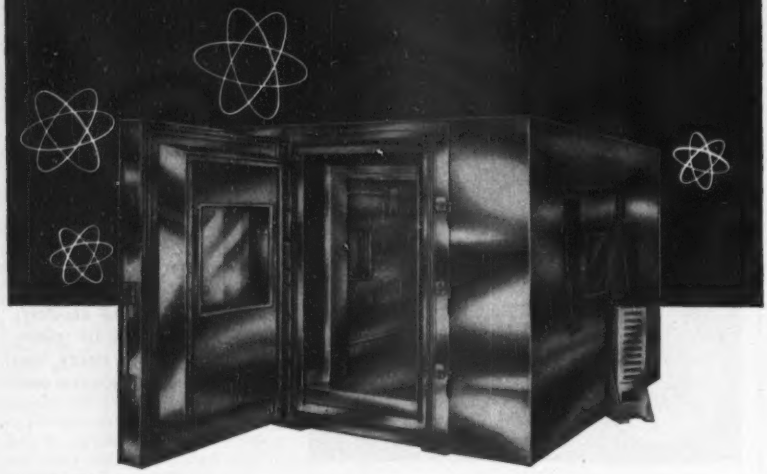
Westinghouse makes SURE.. with BOWSER test equipment



Electronic equipment manufactured by the Electronics Division of Westinghouse Electric in Baltimore must meet rigid performance specifications. To evaluate this equipment under controlled atmospheric conditions, Westinghouse uses a Bowser Walk-In Room which will simulate temperatures from −85° F. to +176° F., and relative humidity from 20% to 95%. In addition, pressures found at altitudes up to 80,000 feet can be created. The entire test facility is operated and controlled from a remote control station.

The complete room was designed, built and installed by Bowser.

This unit is an example of what Bowser can do to help anyone whose products require testing, processing, or stabilized storage. Environmental simulation units, as well as other Bowser equipment, can be engineered to meet individual requirements with unlimited specifications for size, temperature and humidity ranges and peak altitude.

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electrical properties and greater temperature extremes problems.

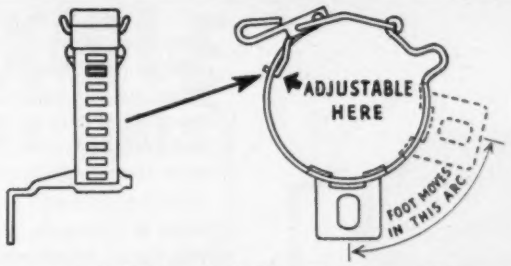
Setting & Adjustment of Adapters. Kinetix Instrument Co., Inc., 902 Broadway, New York 10, N. Y., has announced a 2-page catalog sheet illustrating and describing tools for setting and adjustment of adapters on synchros, resolvers and servo motors. The purpose is described. Also included are diagrammatic methods of recommended mounting.

Synchro Electrical Transformer. Kinetix Instrument Co., Inc., 902 Broadway, New York 10, N. Y. For an illustrated description of receiving electrically the angular position of synchro transmitter rotor and inducing a voltage in the transformer rotor which falls to a null when matched to the angular position of the transmitter, see a recent 2-page perforated catalog. Average electrical characteristics are included.

Microwave Transmission Line. Product Development Co., Inc., 307 Bergen Ave., Kearny, N. J. Technical bulletin No. 28, entitled "Microwave Transmission Line Measured Technical Data" is available upon written request. Complete technical data concerning frequency in mc, peak volts, approximate weight per 20-ft section and nominal characteristic impedance are included.

Potentiometers and Noise. Technology Instrument Corp., 531 Main St., Acton, Mass., has available on request Laboratory Report No. 6. It contains an article entitled "Precision Potentiometers and Noise" by Joseph R. Atieri. Application of the Ponogometer production noise tester is also included as a feature of this report. Causes of potentiometer noise, definition of noise and advantages of the Ponogometer are detailed.

Retractile Cords. Koiled Kords Inc., Box K, New Haven 14, Conn., has available an 8-page bulletin on retractile cords for general communication and power applications. Containing catalog data and in-



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1004	1.862 — 2.000
1005	1.125 — 1.250
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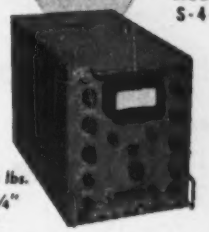
BY WATERMAN

MODEL S-4-A



Weight 31.5 lbs.
9⅛" x 11¼" x 17¼"

Another example of WATERMAN pioneering, a compact, portable instrument for precision pulse measurements adaptable for all electronic work, including radar and TV. S-4-A SAR PULSESCOPE will portray all attributes of the pulse; such as shape, amplitude, duration and time displacement. In S mode of operation, the unit functions as a wide band oscilloscope, with optional video delay, in either repetitive or triggered sweep conditions. In A mode of operation the unit functions as a precision time measuring device, with internal crystal controlled markers available for self calibration. In R mode of operation a desired small segment of A Sweep is expanded to fill the face of the tube for detailed observation.

Video Amplifier band pass up to 11 mc ... optional Video delay 0.55 μs ... Pulse rise and fall time better than 0.07 μs ... Video sensitivity of 0.5 p to p/inch ... S Sweep 80 cycles to 400 KC either triggered or repetitive ... A Sweep 1.2 μs to 12,000 μs, R Delay 3 μs to 10,000 μs ... Directly calibrated on a precision dial ... R Pedestal (or sweep) 2.4 μs to 24 μs ... A & R Sweep Triggers available externally ... Internal crystal markers of 10 μs ± 50 μs ... Built in precision amplitude calibration ... Operates on 50 to 1000 cycles at 115V AC.

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S-10-B GENERAL	POCKETSCOPE
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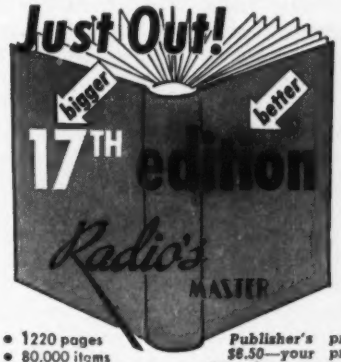

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with experience in

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Hughes Research and Development Laboratories, one of the nation's leading electronics organizations, are now creating a number of new openings in an important phase of their operations.

Here is what one of these positions offers you:

THE COMPANY

Hughes Research and Development Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar systems, electronic computers and guided missiles.

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The positions are for men who will serve as technical advisors to government agencies and companies purchasing Hughes equipment—also as technical consultants with engineers of other companies working on associated equipment. Your specific job would be essentially to help insure successful operation of Hughes equipment in the field.

THE TRAINING

On joining our organization, you will work in the Laboratories for several months to become thoroughly familiar with the equipment which you will later help users to understand and properly employ. If you have already had radar or electronics experience, you will find this knowledge helpful in your new work.

WHERE YOU WORK

After your period of training—at full pay—you may (1) remain with the Laboratories in Southern California in an instructive or administrative capacity, (2) become the Hughes representative at a company where our equipment is being installed, or (3) be the Hughes representative at a military base in this country or overseas (single men only). Compensation is made for traveling and moving household effects, and married men keep their families with them at all times.

YOUR FUTURE

In one of these positions you will gain all-around experience that will increase your value to our organization as it further expands in the field of electronics. The next few years are certain to see large-scale commercial employment of electronic systems. Your training in and familiarity with the most advanced electronic techniques now will qualify you for even more important future positions.

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If you are under thirty-five years of age, and if you have an E.E. or Physics degree, write to the Laboratories, giving resumé of your experience.

Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

formation helpful in ordering as well as photographs of actual applications, the bulletin explains how the cords are made, where they are used and the specific features which make their use advantageous.

Metal & Contacts. Metals & Controls Corp., Attleboro, Mass., has an illustrated, 12-page catalog that describes the various composite metals, precious metals, electrical contacts and Truflex metals manufactured by the company. Contents cover some of the unusual composite metals recently developed; information on the platinum-group metals and manganese age-hardening alloys; and two sections dealing with thin-gage rolling and mirror-finish rolling.

Temperature - Humidity Test Chambers. Tenny Engineering, Inc., 26 Avenue B, Newark 5, N. J., announces a new two-color four-page bulletin on its standard line of temperature-humidity test chambers. Chambers covered can simulate temperatures from −100 F to +200 F and relative humidities from 20 to 95 percent. Specifications give data on heaters, humidification, dehumidification, temperature and humidity controllers, compressor equipment, insulation, exterior construction, access door, air circulation, standard equipment and optional equipment. Chamber construction information, performance characteristics and typical applications are given. Interior dimensions and temperature ranges for eight different standard model types are tabularized in a specification section. Included also are 5 pictures showing typical chambers and chamber applications. Ask for bulletin TR.

Direct-Writing Recorders. Sanborn Co., 38 Osborne St., Cambridge 39, Mass. A new booklet that explains the advantages of using the company's equipment for the study and recording of a wide variety of electrical and mechanical phenomena has been released. It contains 16 pages of pert illustration and pertinent text that describes direct-recording equipment for industrial users.

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DELAY LINES
to meet military specifications

Delay .1 to 2 usec.
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Delay lines are hermetically sealed and are of non-nutrient construction.

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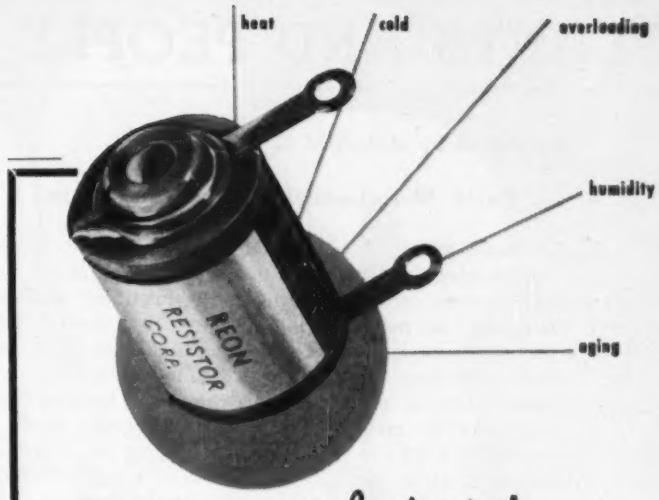

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REON PRECISION WIRE WOUND RESISTORS stay dependable under the most adverse conditions. The resistance changes less than .05% after completion of the MIL-R-93A tests.

The resistor is the heart of your electronic equipment. No other type of resistor has the inherent stability and accuracy of a REON PRECISION WIRE WOUND RESISTOR.

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

RCA To Build Manufacturing Plant In Spain

PLANS of RCA to build a factory in Spain for the production of 45-rpm phonograph records, record players and eventually tv home receivers were recently announced by F. M. Folsom, president of RCA. The proposed plant is expected to be completed in mid-1953. It is to be erected at a 322,000 sq ft site overlooking Madrid, on the main highway to Barajas Airport and the city of Barcelona. Estimated cost of the new plant is $0.5 million. When in full operation it will employ about 1,000 people.

According to RCA's president, a favorable economic climate for electronic development exists in Spain and the country offers a good ground for investment. He noted that a large amount of building was being done in Spain, largely with Spanish capital and not with U. S. ECA funds.

Arrangements for the project were made in cooperation with Gabriel Soria, president and managing director of Industria Electronica S.A., associate RCA company in Spain. Industria Electronica will share the cost of the plant with RCA. Chairman of the board of the new company is Demetrio Carceller, former Spanish Minister of Industry and Commerce. Another former Spanish cabinet minister, Jose Luis de Arreseo, also is a member of the board. He is at present a ranking counselor to the Government of Spain.

Mr. Soria, president of the new company, said that when the opppr-tunity arises, Spanish workers would be sent to the U. S. for further training in RCA factories. Although no tv stations now exist in Spain, plans are in progress that will be developed rapidly.

BENDIX PLANS COMPUTER DIVISION

FORMATION of the Bendix Computer Division of the Bendix Aviation Corp. with headquarters in Hawthorne, California was announced recently by E. Palmer Nicholls (left), vice-president of the Bendix Pacific Division. Maurice W. Horrell (right), former executive engineer of the Bendix Research Laboratories in Detroit, Mich., will head the computer division staff. They are discussing one of the parts used in computers. The new division is being formed for the perfection and manufacture of digital computers designed to provide immediate answers to scientific and industrial problems. Horrell is now organizing a staff of top engineers and scientists for the new division

OTHER DEPARTMENTS
featured for this issue:

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Zworykin Awarded Edison Medal

V. K. ZWORYKIN, pioneer researcher in electronics, has been awarded the 1952 Edison Medal by the AIEE "for outstanding contribution to the concept and design of electronic components and systems". The medal was presented at the opening session of the Winter General Meeting of the Institute at the Hotel Statler.

This honor is the latest of many won by Dr. Zworykin, who is vice-president and technical consultant of the RCA Laboratories Division, RCA, Princeton, N. J. He has been associated with RCA since 1929. Others include the Morris Liebmann Memorial Prize of the IRE for pioneer work in television, the Howard N. Potts Medal of the Franklin Institute for contributions to commercial television, the AIEE Lamme Medal for outstanding contribution to the concept and design

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World's most successful Autochanger

Radio set makers everywhere have acclaimed the Monarch automatic record changer—the brilliant new changer with the exclusive ' Magidisk ' auto-selector ★ Now 7", 10" and 12" records may be intermixed and played at 33⅓, 45 or 78 r.p.m. with a realism and a purity of tone hitherto impossible ★ Simple centralised control provides easy selection of record speed and ' On,' ' Off,' ' Reject ' ★ New extended frequency range dual stylus crystal pick-up faithfully reproduces the most fragile overtones ★ Fine engineering guarantees a lifetime of trouble-free service ★ The price is competitive—send for details.

BSR

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of electronic apparatus basic to modern television, the Poor Richard Club Gold Medal for Achievement, and the Chevalier Cross of the French Legion of Honor in recognition of his contribution to victory in World War II.

The Edison Medal, first awarded in 1909, has been won by such outstanding scientists as Alexander Graham Bell, George Westinghouse, Frank B. Jewett, and Vannevar Bush. The medal was founded by associates and friends of Edison.

MIT Appoints Electronics Lab Research Heads

GEORGE G. HARVEY, associate professor of physics, and Henry J. Zimmermann, associate professor of electrical engineering, have been appointed associate directors of the Research Laboratory of Electronics at MIT.

Frank White Elected President of NBC

FRANK WHITE, vice-president and general manager of the radio and television networks of NBC, has been elected president and a director of NBC to succeed Joseph H. McConnell.

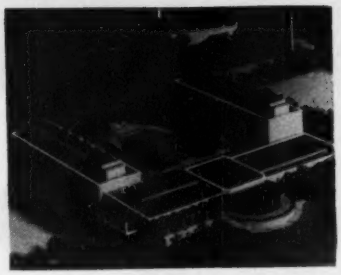
Mr. McConnell has resigned from NBC to join a company in another industry, and his new position will be announced by that company. It is reported that he will become president of the Colgate-Palmolive-Peet-Co.

Sylvester L. Weaver, Jr., vice-president in charge of the radio and television networks of NBC, was elected vice-chairman of the NBC board of directors, a new position.

John K. Herbert, vice-president in charge of network sales, has been appointed to succeed Mr. Weaver as vice-president in charge of the radio and television networks.

CAPTAIN ROUND RECEIVES ARMSTRONG MEDAL

Capt. Henry J. Round of England (right) received the prized Armstrong Medal from John Bose, president of the Radio Club of America, at the Club's 43rd annual banquet. The Medal was awarded to Capt. Round in recognition of his pioneering work in radio, especially in the fields of radio direction and position finding and the amplification of short-wave signals. During World War I the direction-finding apparatus he designed and operated made it possible to trace the movements of the German Fleet, making possible interception by the British Fleet in the Battle of Jutland



IBM To Build New Electronics Center

INTERNATIONAL business machines Corp. has announced plans to begin construction of a research center near its Poughkeepsie, N. Y., plant early next spring, to be completed before the end of 1954. The plant, a model of which is shown above, will add 179,000 square feet of floor space to the company's existing laboratory facilities. An estimated 750 employees will work in the building. The research center will provide centralized facilities for the company's widespread electronics research program.

Honeywell Elects Seidel V-P

GLENN E. SEIDEL has been elected a vice-president of Minneapolis-Honeywell Regulator Company in charge of engineering in the company's Minneapolis plants, Harold W. Sweatt, president, announced recently.

Seidel, a member of Honeywell's engineering organization since 1943, has been director of the company's expanding ordnance division for the past year and a half. Before that he served for a number of years as assistant to W. J. McGoldrick who, as part of his duties as vice-president, has been handling the engineering activities that Seidel will take over.

Outstanding Engineers Honored

THE ETA KAPPA NU plaque designating the most outstanding young electrical engineer for 1952 was awarded to John V. N. Granger, 34, of the Stanford Research Institute, Stanford, California. In addition Edward O. Johnson, 33, of RCA Laboratories, Princeton, New Jersey and Gustave W. Staats, 33, of the Allis Chalmers Mfg. Co., Mil-

NOW! smallest coax assemblies

1/4 BNC size to do a bigger job

MICRODOT, pioneer of micro-miniaturization, has completed development of Coaxial Assemblies one-quarter BNC size with savings in weight of 87% to a comparable BNC* assembly...and designed to do a BIGGER job on top of these outstanding size and weight advantages.

COMPARE these characteristics for instrument hook-ups, transistor packaging, computer and airborne components, etc. Here's how big a job a Microdot Coax Assembly can do for you.

MICRODOT	ELECTRICAL ADVANTAGES
Characteristic impedance	50 or 70 ohms
Capacity	30 mmf/ft or 21mmf/ft
Low VSWR	1.3
Low insertion loss (400 mc)	0.3 DB/ft
High voltage breakdown	2500 DC
High temperature stability	— 65° to + 300° F.

Special MININOISE *treatment reduces self-generated cable noise by 95% compared to standard cable.*

IMMEDIATE DELIVERIES!

Single and double-ended assemblies, feed-throughs and couplings—immediately available for delivery. Write today. Ordering information and data will reach you promptly.

Patents Pending

**Compared to BNC Connectors and RG59U cable.*

VIBRATION RESISTANCE

Microdot Assemblies resist 5 to 55 cps at 25 G's. Mininoise treated cable makes high termination impedances practical.

FLEXIBLE

The MININOISE Cable (0.10" diameter) can be wrapped around a 0.5" mandrel without change.

SMALL SIZE

A— the male and female joined diameter is 0.22".
B— the male and female joined length is 0.85".
C— the thread size is 10/32.

4

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SYNCHROS

Precision-Built by

ECLIPSE-PIONEER

For more than 18 years, Eclipse-Pioneer has been a leader in the development and production of high precision synchros for use in automatic control circuits of aircraft, marine and other industrial applications. Today, thanks to this long experience and specialization, Eclipse-Pioneer has available a complete line of standard (1.431" dia. X 1.631" lg.) and Pygmy (0.937" dia. X 1.278" lg.) Autosyn synchros of unmatched precision. Furthermore, current production quantities and techniques have reduced cost to a new low. For either present or future requirements, it will pay you to investigate Eclipse-Pioneer high precision at the new low cost.

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AVERAGE ELECTRICAL CHARACTERISTICS—AY-200 SERIES**

	Type Number	Input Voltage Nominal Excitation	Input Current Milliamperes	Input Power Watts	Input Impedance Ohms	Stator Output Voltage Line to Line	Rotor Resistance (DC) Ohms	Stator Resistance (DC) Ohms	Maximum Error Spread Minutes
Transmitters	AY201-1	26V, 400~, 1 ph.	225	1.25	25+j115	11.8	9.5	3.5	15
	AY201-4	26V, 400~, 1 ph.	100	0.45	45+j225	11.8	16.0	6.7	20
Receivers	AY201-2	26V, 400~, 1 ph.	100	0.45	45+j225	11.8	16.0	6.7	45
Control Transformers	AY201-3	From Trans. Autosyn	Dependent Upon Circuit Design				42.0	10.8	15
	AY201-5	From Trans. Autosyn	Dependent Upon Circuit Design				250.0	63.0	15
Resolvers	AY221-3	26V, 400~, 1 ph.	60	0.35	108+j425	11.8	53.0	12.5	20
	AY241-5	1V, 30~, 1 ph.	3.7	—	240+j130	0.34	239.0	180.0	40
Differentials	AY231-3	From Trans. Autosyn	Dependent Upon Circuit Design				14.0	10.8	20

**Also includes High Frequency Resolvers designed for use up to 100KC (AY251-24)

AY-500 (PYGMY) SERIES

Transmitters	AY503-4	26V, 400~, 1 ph.	235	2.2	45+j100	11.8	25.0	10.5	24
Receivers	AY503-2	26V, 400~, 1 ph.	235	2.2	45+j100	11.8	23.0	10.5	90
Control Transformers	AY503-3	From Trans. Autosyn	Dependent Upon Circuit Design				170.0	45.0	24
	AY503-5	From Trans. Autosyn	Dependent Upon Circuit Design				550.0	188.0	30
Resolvers	AY523-3	26V, 400~, 1 ph.	45	0.5	290-(-)490	11.8	210.0	42.0	30
	AY543-5	26V, 400~, 1 ph.	9	0.1	900+j2200	11.8	560.0	165.0	30
Differentials	AY533-3	From Trans. Autosyn	Dependent Upon Circuit Design				45.0	93.0	30

For detailed information, write to Dept. C.

ECLIPSE-PIONEER DIVISION of Bendix AVIATION CORPORATION

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waukee, Wisconsin received honorable mention citations.

Citations presented to the men were as follows:

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"By virtue of his noteworthy researches on aircraft radio antennas, his organization and direction of a large radiation systems laboratory, and his unusual interest in cultural and professional activities, Eta Kappa Nu recognizes John Van Nuys Granger as an outstanding young American engineer."

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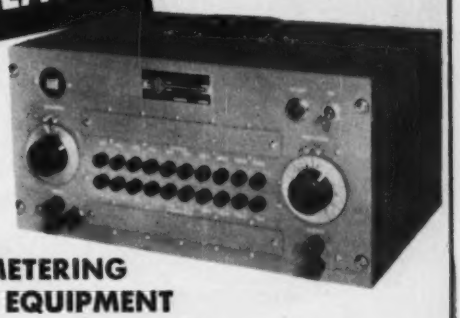

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Style No. 2906

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Sturdily constructed for maximum life. Finished in semi-gloss black enamel. Ribbed, firm-gripping clamping pads made of hard neoprene. Mounting plate enables clip to be attached to hard surface, such as a switch case. Hard drawn steel spring wire insures optimum spring action.

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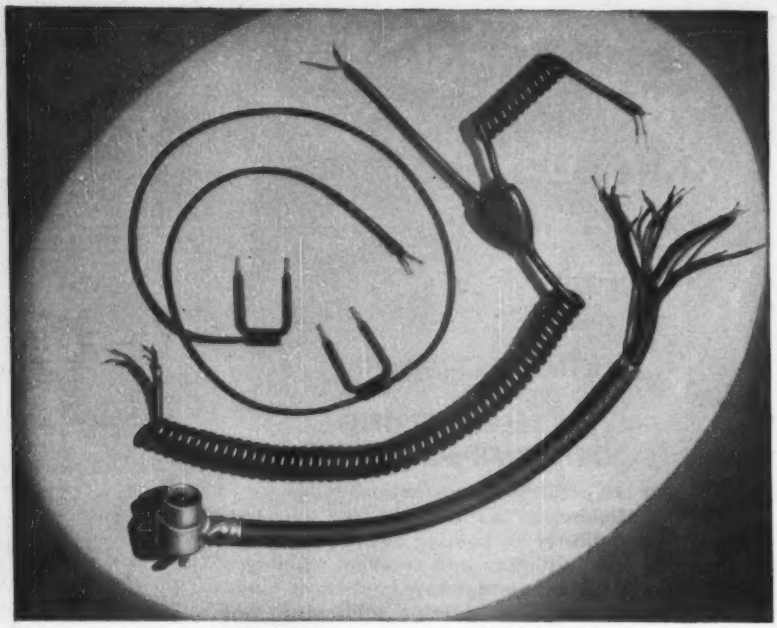

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"By virtue of his outstanding contributions to the design and construction of supercharged hydrogen cooled turbine generators, and his extraordinary participation in the life of his community, Eta Kappa Nu recognizes with honorable mention Gustav W. Staats."

Motorola To Expand Plant

MOTOROLA president Paul V. Galvin announced that his company plans to spend $3 million for a plant expansion program in 1953. A major new plant will be built in Franklin Park, Illinois which will nearly double the production capacity of the electronics firm's television manufacturing facilities. Some 27½ acres of land have been acquired to accommodate the single large structure measuring 833 feet by 325 feet, embracing 278,000 square feet of usable factory space.

Paul V. Galvin

The new facilities will constitute a bulk assembly plant for final assembly, packing, storing and shipping of tv units. The completion of the new plant, with all installations necessary for operation, is anticipated by mid-year.

GE Elects Vice-Presidents

PRESIDENT Ralph J. Cordiner of the General Electric Company announced that general managers of eight operating divisions of the company have been elected vice-

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Model 601 Vacuum Tube Volt-Ohm-Milliammeter

An accurate, universal test instrument . . . Battery operated, over 100 hours of battery life . . . Extremely useful when external power is not available . . . Useful when limitations are imposed by A. C. power grounds; prevents 60 cycle hum . . . Effectively measures ungrounded or symmetrical circuits.

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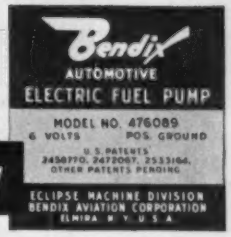

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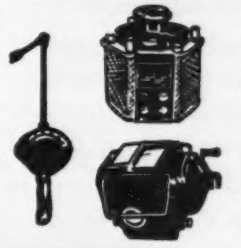

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SC53-4

presidents by the board of directors. Mr. Cordiner said that the promotions were made in furtherance of the company's announced plan of decentralization.

Those elected were: James M. Crawford, general manager of the Motor and Generator Division, Schenectady, N. Y.; Francis E. Fairman, general manager of the Transformer and Allied Products Division, Pittsfield, Mass.; Cramer W. LaPierre, general manager of the Aircraft Gas Turbine Division, Evendale, Ohio; Clarence H. Linder, general manger of the Major Appliance Division, Louisville, Ky.; Harold A. MacKinnon, general manager of the Component Products Division, Fort Wayne, Ind.; Charles K. Rieger, general manager of the Small Appliance Division, Bridgeport, Conn.; Glenn B. Warren, general manager of the Turbine Division, Schenectady; and William C. Wichman, general manager of the Industrial Power Components Division, Plainville, Conn.

Warde B. Stringham of Washington, D. C. has been elected a commercial vice-president of GE.

Zenith Plans Expansion

DIRECTORS of Zenith Radio Corporation have authorized new construction that will add more than 300,000 square feet of floor space to the company's main plant at 6001 Dickens Avenue, Chicago, it was announced by Hugh Robertson, executive vice-president.

The new space will be used chiefly to provide additional packing and shipping facilities required for the steadily increasing volume of Zenith's production.

Construction will begin as soon as final drawings are completed, and is scheduled for completion within a year. With this new addition Zenith and subsidiary companies will have total floor space exceeding 1.8 million square feet. Estimated cost of the new addition is $3 million.

Bendix Names Chief Engineers

ALBERT E. NAMEY has been promoted to the position of chief engineer of the Test Equipment Design

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THE ONLY PERSONAL PART OF ANY COMMUNICATION SYSTEM

*MONOSET
The modern styling and dependability and superior performance of the TELEX Monoset have made old fashioned headphones obsolete. Magnetic.

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New dynamic under-chin TELEX Dynaset, with more highs and lows of both music and speech, is the delight of radio and TV monitors. Weighs only 1.25 oz.

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This lightweight 1.6 oz. TELEX Twinset pipes signal directly into the ear, blocking out background noises and banishing listening fatigue. Magnetic.

*EARSET
Sensitive TELEX Earset slips onto ear and is preferred by all who use single-phone headsets. Weighs only ½ oz. and leaves other ear free for phone calls or conversation.

Modern, lightweight, durable . . . Easily adjustable and built for hard usage, TELEX Headsets give top quality reception without the punishment of extra weight and pressure.

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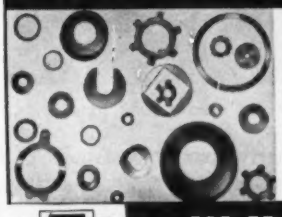

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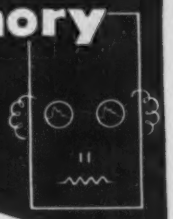

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Department at the Towson Plant of Bendix Radio, Division of Bendix Aviation Corporation, it was announced recently by A. C. Omberg, Director of Engineering and Research. He will be responsible for the design, production and purchase of all test equipment used by Bendix Radio and also maintain custody of all primary standard equipment and climatic and environmental test equipment.

Norman Caplan has been named to the position of Chief Engineer of the Military Communication and Navigation Engineering Department of the Bendix Radio Division. He will be responsible for the administration of the design and developmental work currently being undertaken in connection with military communication and navigation equipment programs. Prior to this appointment, he occupied the position of Chief Engineer of the Test Equipment Design Department.

Sparks-Withington Names Fisk Chief Engineer

SPARKS-WITHINGTON COMPANY, Jackson, Michigan, announced the appointment of Harry Fisk as chief electronics engineer of the company's Sparton Radio-tv division. He replaces H. H. Knubbe who served Sparton in that capacity for five years.

Harry Fisk

Formerly Sparton assistant chief electronics engineer, Fisk has been a major factor in Sparton engineering and research for 26 years. In his new post, Fisk will be responsible for all engineering research at

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. . . the smallest in the world!
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FIELD STRENGTH METER

for TV and FM – it will actually read microvolts!

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MODEL 704 with AC power supply

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Microvolts and db meter scales
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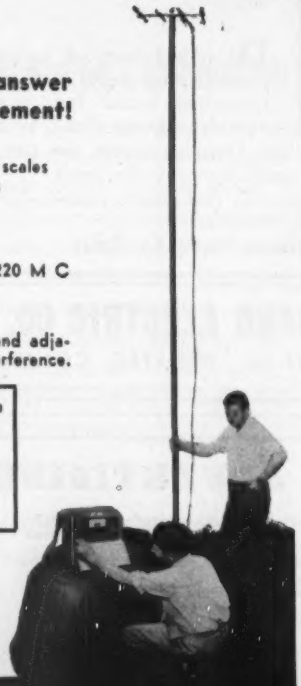

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Sparton as well as engineering supervision of the company's radio, television and government projects.

Admiral Works On Color TV

ADMIRAL CORP. announced an established research laboratory for color television at Palo Alto, Calif., near the campus of Stanford University. The company has more than 20 engineers working on various phases of color television and other electronic developments. Robert M. Jones is director of research at Palo Alto.

Sylvania Names McClintock

APPOINTMENT of Raymond K. McClintock to the newly created post of manager of new product promotion of Sylvania Electric Products Inc. was announced by B. K. Wickstrum, vice-president and director

New Sylvania product promotion manager

of sales. From company headquarters in New York City, he will be responsible for fostering the promotion and sale of new products and for exploratory work leading to the consideration of new lines of products by Sylvania.

Magnecord Sets Expansion

ARRANGEMENTS for $300,000 additional capitalization have been completed by Magnecord, Inc., Chicago, manufacturer of professional magnetic tape recording equipment. The funds are to come from Ameri-

one week delivery

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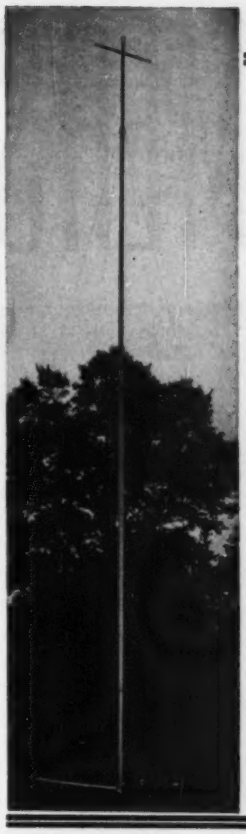

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- Criton Masts and Antenna Supports are made of Fibre Glass Reinforced Thermosetting Plastic Tubing
- Weight—approx. 1/5 of Steel, ½ of Aluminum
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- Standard 43¼", 67¾", and 83½" heights.
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- The door is stamped from one piece of steel and reinforced — with formed, clean, smooth, double thick edges.
- "Multiracks" available with closed or open intermediate sides for rack-to-rack wiring.
- Streamlined modern design; beautiful finish.

Planning an electronic product? Consult Par-Metal for

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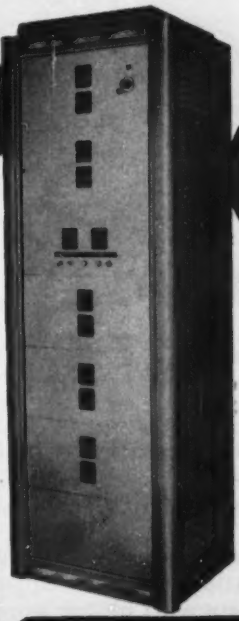
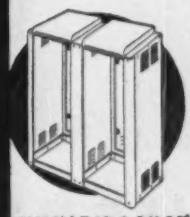
Remember, Par-Metal equipment is made by electronic specialists, not just a sheet metal shop.

Made by Electronic Specialists!





"MULTIRACKS"

These Racks may be assembled in multiple units as shown above.

SHELVES available.

Also ROLLER TRUCKS available for single racks or "Multiracks".

NO INCREASE IN COST!

The ER-225 is priced to compete with racks not having the equivalent features. Beyond doubt — it's the industry's greatest value.

The ER-225 Rack as used by the American Communications Corp., N. Y. C. 13.

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Latest NYT service for customers is a complete test laboratory equipped and approved for on-the-spot MIL-T-27 testing and faster approvals.

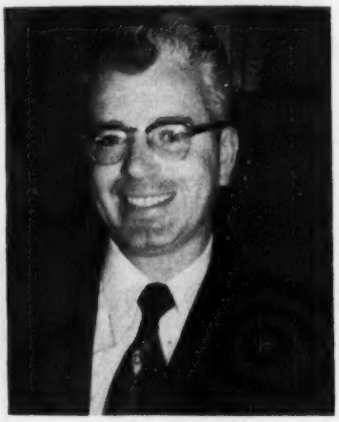
NEW YORK TRANSFORMER CO., INC.
ALPHA, NEW JERSEY

can Research and Development Corporation, Boston, Mass.

In announcing the increased capitalization, A. P. Buetow, executive vice-president of Magnecord, outlined a broad program of general expansion. Plans call for immediate extension of manufacturing facilities.

R. J. Sullivan Joins Fairchild

ROBERT J. Sullivan has joined the Potentiometer Division of the Fairchild Camera and Instrument Corporation at its Hicksville, N. Y. plant, to act as head of research and development. He was formerly chief of the Potentiometer Research Unit of the Air Force Cambridge Research Center, Cambridge, Mass.



New research head

At Fairchild, he will guide a new effort towards continual improvement in potentiometer design to meet the stringent requirements of both the military and industrial markets.

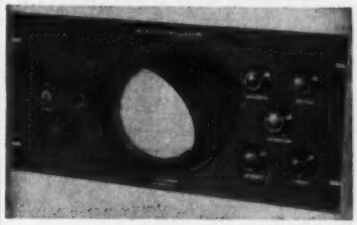
Hallicrafters Names Graver and Wilson

RICHARD A. GRAVER, formerly vice-president and general manager of the Capehart-Farnsworth Corp., Ft. Wayne, Ind., has been appointed vice-president and director of marketing of the Hallicrafters Co.

Mr. Graver's position at Hallicrafters is a new one with more comprehensive duties than those of the former vice-president in charge of sales, Roland J. Sherwood, who recently resigned to form an auto

A NEW RACK-MOUNTING

5" BASIC SCOPE



A new 5" rack mounted basic oscilloscope of high quality parts and design.

- Push-Pull input with blanking post.
- Potted power transformer.
- 2,200 volt anode supply for short, medium and long persistence screens.
- Astigmatism control on panel.
- ¼" lucite safety glass and grating.
- Flanged bezel for scope cameras.
- Mu metal C. R. tube shield.
- Standard 8¾"x19" rack panel in black or grey engraved crackle.

All high quality parts and workmanship are used in this excellent indicating unit. Balanced input signal connections are at rear of C. R. tube with low capacity leads. Furnished with 5UP1, 5UP7 or 5UP11 as requested. Available for immediate delivery.

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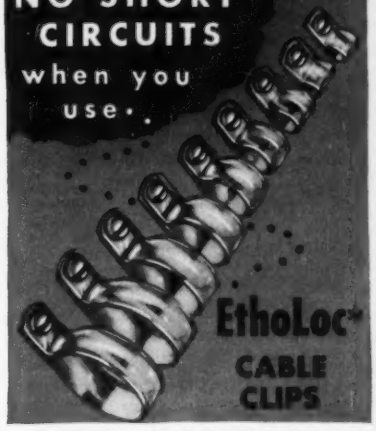

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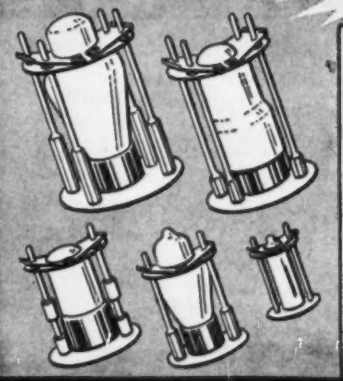


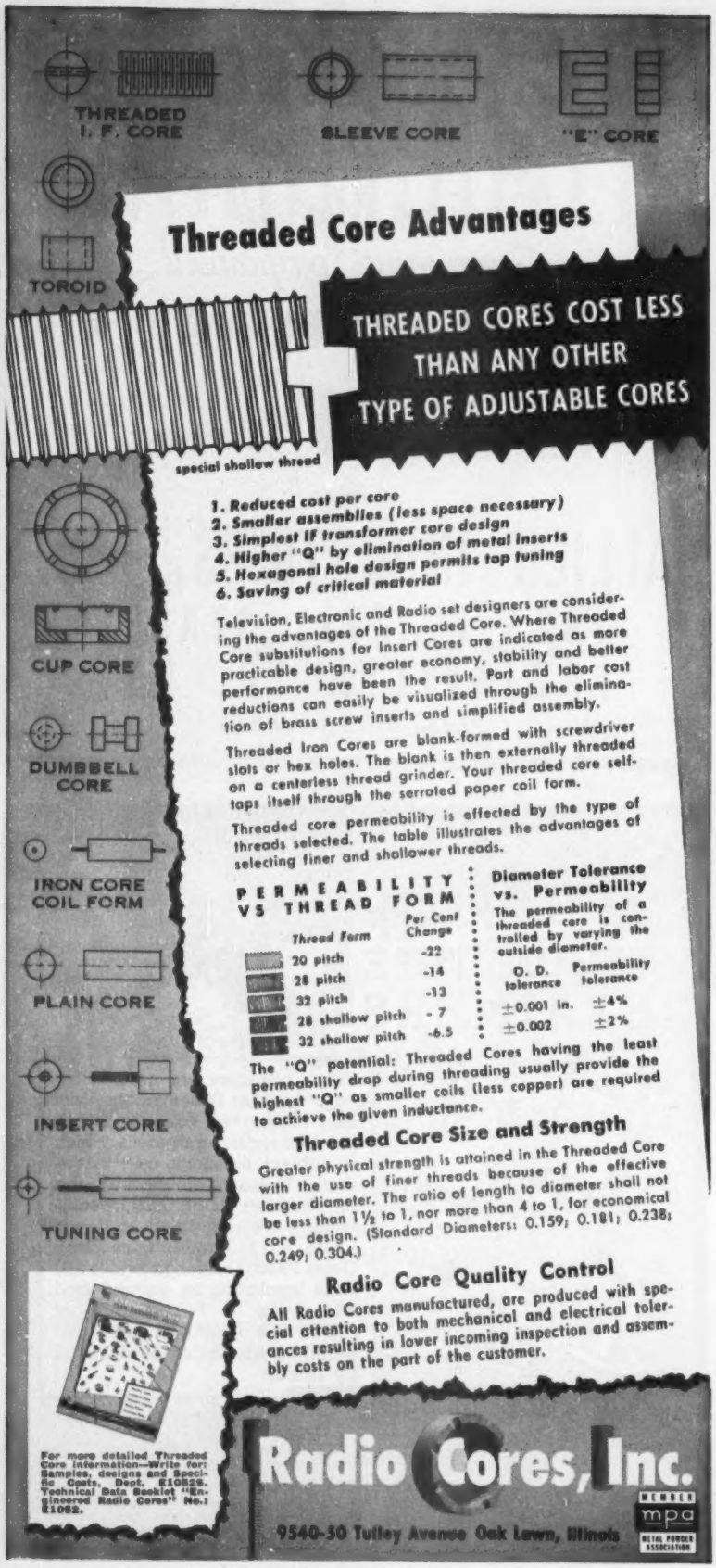
These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T12ZDI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.

401 CONCORD AVENUE, BRONX 54, N. Y.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TOROID
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THREADED CORES COST LESS THAN ANY OTHER TYPE OF ADJUSTABLE CORES
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3. Simplest IF transformer core design
4. Higher "Q" by elimination of metal inserts
5. Hexagonal hole design permits top tuning
6. Saving of critical material
Television, Electronic and Radio set designers are considering the advantages of the Threaded Core. Where Threaded Core substitutions for Insert Cores are indicated as more practicable design, greater economy, stability and better performance have been the result. Part and labor cost reductions can easily be visualized through the elimination of brass screw inserts and simplified assembly.
Threaded Iron Cores are blank-formed with screwdriver slots or hex holes. The blank is then externally threaded on a centerless thread grinder. Your threaded core self-taps itself through the serrated paper coil form.
Threaded core permeability is effected by the type of threads selected. The table illustrates the advantages of selecting finer and shallower threads.
PERMEABILITY VS THREAD FORM
Thread Form
Per Cent Change
20 pitch -22
28 pitch -14
32 pitch -13
28 shallow pitch -7
32 shallow pitch -6.5
Diameter Tolerance vs. Permeability
The permeability of a threaded core is controlled by varying the outside diameter.
O. D. tolerance
Permeability tolerance
±0.001 in. ±4%
±0.002 ±2%
The "Q" potential: Threaded Cores having the least permeability drop during threading usually provide the highest "Q" as smaller coils (less copper) are required to achieve the given inductance.
Threaded Core Size and Strength
Greater physical strength is attained in the Threaded Core with the use of finer threads because of the effective larger diameter. The ratio of length to diameter shall not be less than 1½ to 1, nor more than 4 to 1, for economical core design. (Standard Diameters: 0.159; 0.181; 0.238; 0.249; 0.304.)
Radio Core Quality Control
All Radio Cores manufactured, are produced with special attention to both mechanical and electrical tolerances resulting in lower incoming inspection and assembly costs on the part of the customer.
CUP CORE
DUMBBELL CORE
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PLAIN CORE
INSERT CORE
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For more detailed Threaded Core information—Write for: Samples, designs and Specific Costs, Dept. E10B28. Technical Data Booklet "Engineered Radio Cores" No. E1082.
Radio Cores, Inc.
9540-50 Tulley Avenue Oak Lawn, Illinois
MEMBER mpa METAL POWDER ASSOCIATION

parts manufacturing business of his own.

At Hallicrafters, Mr. Graver will be in complete supervision of all merchandising, marketing and advertising activities of the company.

M. Robert Wilson, prominent major appliance sales executive, has been appointed vice-president in charge of sales for Hallicrafters Co.

IRC Elects Officers

THE board of directors of the International Resistance Company, Philadelphia, elected Ernest Searing chairman of the board of directors. Charles Weyl, formerly executive vice-president, was elected president.

JFD Completes Plant

JFD MANUFACTURING COMPANY, INC., has just announced the completion of a new plant that will expand the company's factory space to a total of more than 200,000

JFD factory

square feet. In addition, a 32,000 square foot area recently purchased will be eventually utilized for another factory, according to Julius Finkel, president of JFD.

Barthel Board Chairman of NEC

CHRISTOPHER E. BARTHEL, JR., was elected chairman of the board of directors of the National Electronics Conference. Starting his fourth year as a member of the NEC board, Dr. Barthel succeeds Kipling Adams of General Radio Company. During the current year, he was chairman of the publications committee which prepared the proceedings for the organization's eighth annual conference and exhibition in Chicago.

Ransom Joins Karl-Douglas As Chief Engineer

DAVID H. RANSOM, formerly director of research at Bogue Electric

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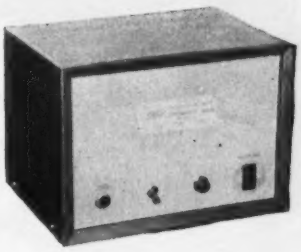

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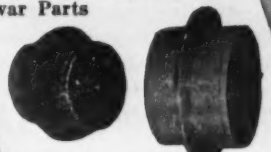

Hydrogen Thyratron Tube Bases up to 6.25 diameter.

Tungsten leads are important factors in a tube. High quality leads make quality tubes. The Engineering Co. makes the finest leads. No leakage or breakage when you buy our leads. Parts made to customers' specifications. Quality tubes depend upon quality bases and caps. We make all types including an all - glazed ceramic base.
Our engineers will be happy to help you with any of your problems.

THE ENGINEERING CO.
27 WRIGHT STREET, NEWARK 5, NEW JERSEY

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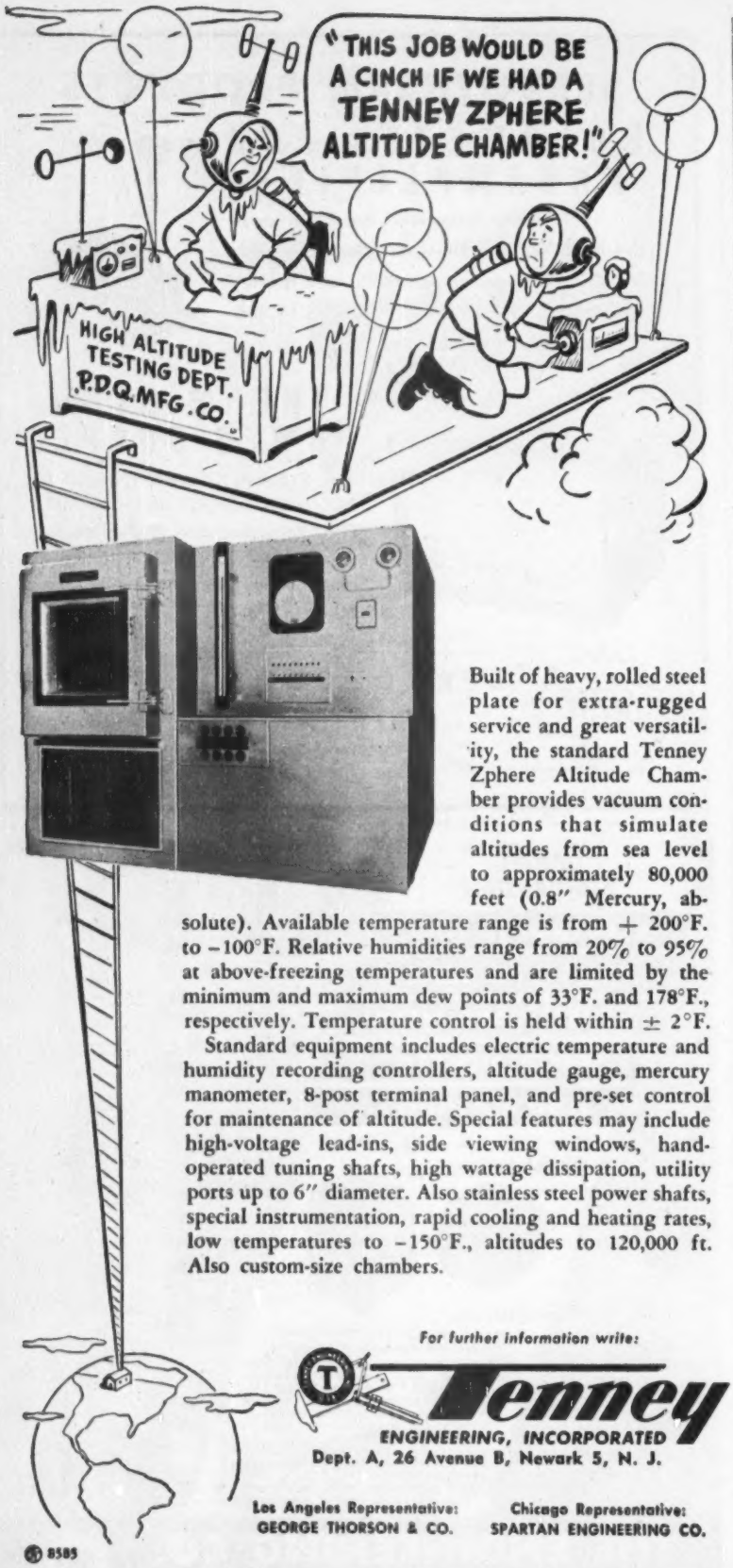

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Standard equipment includes electric temperature and humidity recording controllers, altitude gauge, mercury manometer, 8-post terminal panel, and pre-set control for maintenance of altitude. Special features may include high-voltage lead-ins, side viewing windows, hand-operated tuning shafts, high wattage dissipation, utility ports up to 6" diameter. Also stainless steel power shafts, special instrumentation, rapid cooling and heating rates, low temperatures to −150°F., altitudes to 120,000 ft. Also custom-size chambers.

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8585

Engineers and Manufacturers of Automatic Environmental Test Equipment

Manufacturing Co., Paterson, N. J. has been appointed chief engineer of the Electronic Division of Karl-Douglas Associates, Hawthorne, California. In his new duties he will direct the design and production of various electronic and electrical products, including a new line of magnetic amplifiers.

Randall Named RDB Electronics Head

WALTER G. WHITMAN, chairman of the Research and Development Board of the Department of Defense, announced the appointment of Henry Randall as executive director of the RDB Committee on Electronics.

Randall has been associated with RDB since March, 1948, having served successively with the Planning Division, the Committee Coordination Division in the Office of the Vice-Chairman, and as acting executive director of the Committee on Electronics.

Canadian Radio Board Re-elects Officers

R. A. HACKBUSCH of Toronto, president and managing director of Stromberg-Carlson Co. Ltd., was re-elected president of the Canadian Radio Technical Planning Board at the eighth annual meeting of the Board.

C. W. Boadway, communications engineer, Ontario Hydro Electric Power Commissioner was re-elected vice-president and Stuart D. Brownlee of Toronto was re-elected Secretary-Treasurer.

Mr. Hackbusch in his annual report pointed out that 160 of the top-ranking engineers, scientists and specialists of all kinds in the electronic fields have been devoting a considerable portion of their time and effort to planning the future of electronics in Canada.

LaPointe-Plascomold Appoints Damerel

WILLIAM A. DAMEREL has been appointed to the position of assistant to the president, it was announced by J. E. Respess, president of the LaPointe-Plascomold Corporation. Damerel, who was with the Maxim

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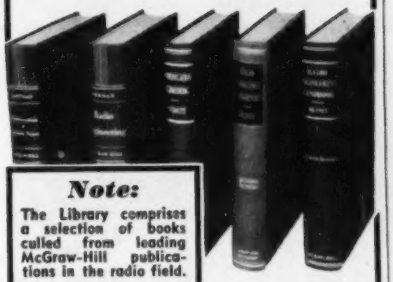

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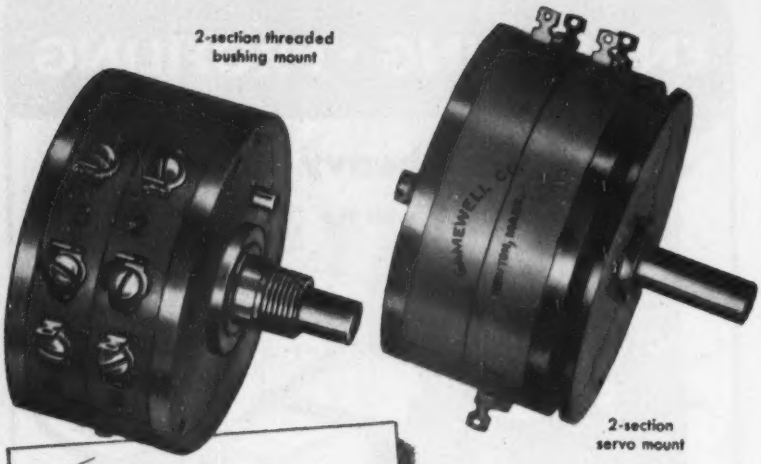

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Max. Resistance (ohms) ± 10%	160,000
Min. Resistance (ohms) ± 10%	105
Max. Useful Angle (deg.)	354 ± ½
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Min. Resolution (%)	0.025
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Allow ⅛" for each additional section up to five. Can be supplied in diameters 1¼" — 1⅝" — 3" — 5".

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Silencer Company, Hartford, Connecticut, will coordinate all phases of administration. He will aid Mr. Respess in the formulation of overall company planning and policies.

Bogen In New Quarters

THE DAVID BOGEN COMPANY, INC., has completed the removal of its complete plant facilities to new quarters at 29 Ninth Avenue in New York City. The building, which contains a total of 70,000

New Bogen plant

square feet of area on six floors and basement, will permit expansion of all departments, especially engineering laboratories and production facilities for the company's new products.

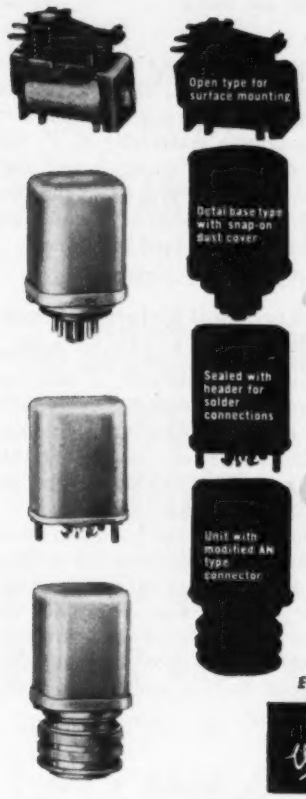
MASCO Appoints Two Executives

RALPH AASEN has been appointed chief engineer and G. L. Werner has been appointed director of sales engineering of Mark Simpson Mfg. Co., Inc. of Long Island City, New York, it was announced by John A. Van Auken, general manager.

Stackpole Promotes Five

DR. E. J. SHOBERT has been appointed manager of carbon research and engineering for the Stackpole Carbon Co., St. Marys, Pa., and Henry M. Dressel will serve as director of research and engineering for the firm's electronic components division.

Other Stackpole appointments also announced by H. S. Conrad,


Open type for surface mounting
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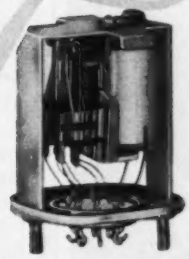
Sealed with header for solder connections
Unit with modified AN type connector

a rugged little space saver . . .

MIDGET TELEPHONE TYPE RELAYS SERIES (80)—OPEN TYPE FOR SURFACE MOUNTING, OR IN HERMETICALLY SEALED CONTAINERS.



This vibration and shock-proof Midget Type Relay is the answer to numerous applications where unfailing operation is necessary. In fact, it is built to meet rigid Army and Navy specifications. This "rugged little space saver" is a compact, multiple contact relay which has been developed over years of specialized engineering in the field by Signal Engineering and Mfg. Co., manufacturers of a comprehensive line of relays and signals of various designs and sizes.

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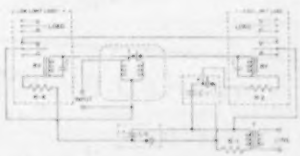
The dial can indicate current, volts or temperature, or it can show delay in seconds. Timing is little affected by temperature or pressure. The relay uses no condensers, dash pots nor motors so size and weight are small.

SPST or SPDT contacts are self locking, rated five milliamperes DC for one million operations—ratings to 500 milliamperes for reduced number of operations. Contacts are locked by an extra coil in meter—released by braking circuit to that coil. Non-locking contacts can be supplied for special applications.

Normal reset time is about the same as operate time. Special adaptions provide fast operate, slow release or slow operate, fast release. Delay is adjusted by setting index pointer. Or, relays may have fixed setting. They are adaptable to hermetic seal.

Here are typical specifications:

Cat. No. 306-7000, range 0-10 seconds, 0-1 DCMA, 100 ohms $30.00
Cat. No. 306-7002, range 0-5 seconds, 0-50 DCUa, 2800 ohms $45.00
Cat. No. 705-7003, range 0-10 seconds, 0-150 AC volts $47.00



Simplytrol Double CMR Improved Self-Releasing Circuit

There are so many possible variations for these relays it is suggested that engineers submit descriptions of proposed use. Include diagrams of associated circuits. Write Bradley Thompson, Assembly Products, Inc., Chagrin Falls 16, Ohio. Phone 7374.

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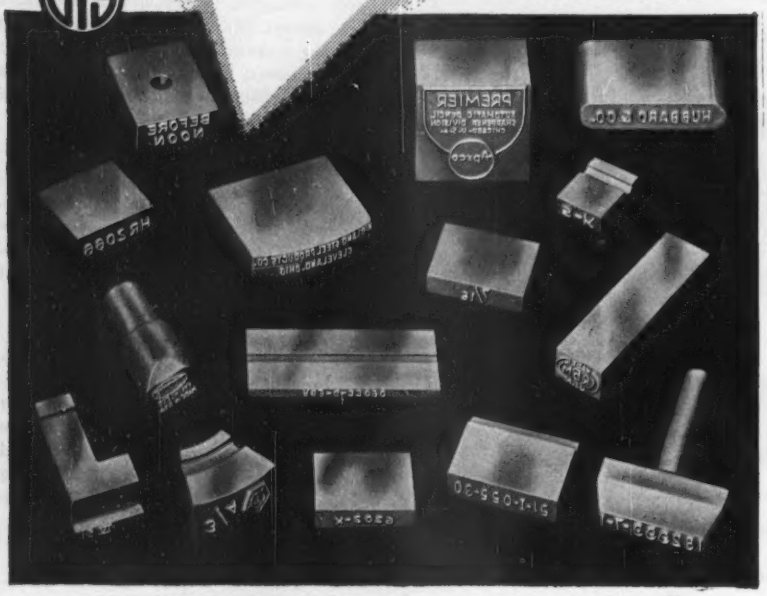

For legible permanent marking of metal components use GTS engraved lettering tools. Precision engraved dies and inserts for indenting or embossing identification on your parts will

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vice-president and general manager, include: L. D. Andrews, director of research and engineering on magnetic materials; E. F. Kiefer, director of research and engineering on carbon products; and F. X. Sorg, director of research and engineering on fixed resistors.

Packard-Bell Enlarges Plant

PACKARD-BELL CO., Los Angeles radio-tv manufacturer, is now constructing a new 92,460 sq ft addition to its Los Angeles main plant. Building and equipment together will represent an investment exceeding $750,000.

The addition will have two units, one housing a division for milling and assembling tv cabinets and the other housing the electronics division for government contracts. When this addition is completed, the total facility will contain 250,000 sq ft.

Capehart Names Manufacturing V-P

L. G. HAGGERTY was elected vice-president in charge of manufacturing of the Capehart-Farnsworth Corporation, associate of IT&T, at a meeting of the firm's directors in Chicago.

Arma Advances Walz

ALLEN W. (SKIP) WALZ has been advanced by Arma Corporation, subsidiary of American Bosch Corporation, to executive staff assistant to Clifton T. Foss, Arma's vice-president for engineering. His executive position is a newly created one made necessary by the tremendous blacklog of orders, now on Arma's books, requiring engineering and development work. The Engineering Division of Arma Corporation now has some 1,700 employees.

Allied Radio Builds $2 Million Building

RAPID progress is being made on a new $2 million building of Allied Radio Corporation, Chicago, national distributor of electronics

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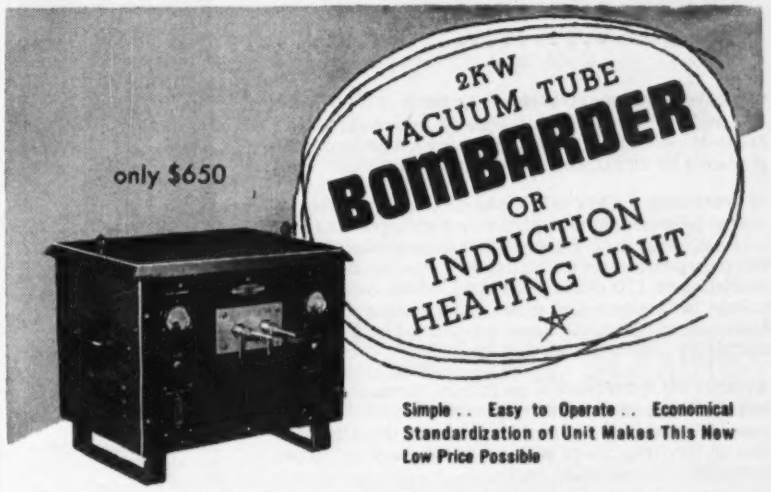

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Never before a value like this new 2-KW bench model "Bombarder" or high frequency induction heater . . . for saving time and money in surface hardening, brazing, soldering, annealing and many other heat treating operations.

This compact induction heater saves space, performs with high efficiency. Operates from 220-volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. Specify time cycle required for your particular job. We will quote on proper size unit for your requirements. Immediate delivery.

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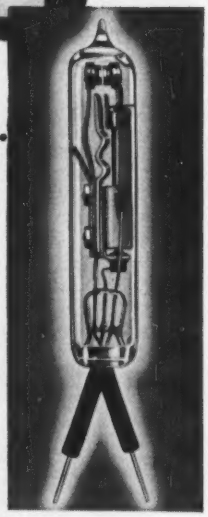

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EDISON THERMOSTATS feature stability measured in years, control within ±0.1° F and capacity to 115 volts, 8 amperes d.c. or 1000 watts. EDISON temperature control engineers will be glad to work with you on the solution of your ambient protection problems. Just call or write to:

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parts and equipment. With a total floor space of 150,000 square feet, the new center is expected to be ready for occupancy this summer.

A. D. Davis, president of Allied, points out that the firm's rapidly expanding sales have been keeping pace with the phenomenal growth of the electronics industry. The firm now stocks 19,000 items, with an increase to 25,000 anticipated within a few years. Processing of 7,500 shipments daily instead of the current peak of 4,000 daily will be possible in the new building. Allied maintains a $2.5 million inventory to meet everyday demands for electronic products.

New NBS Lab Under Way

CONSTRUCTION has begun on a major laboratory of the National Bureau of Standards at Boulder, Colorado. The new building will house the Bureau's Central Radio Propagation Laboratory on a 210-acre site directly south of the city. Complete and modern facilities are to be provided for research on the propagation of radio waves and on the expanded utilization of the radio spectrum now being used for f-m, television, facsimile and radar.

The new building is scheduled for completion in early 1954. By mid-1954 a staff of about 500 will be employed there.

OTHER NEWS

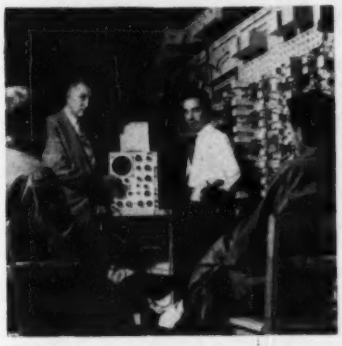
Westinghouse Readies Round-The-World Sub

THREE nuclear power plants of major size are under construction or design at Westinghouse. One, known as Mark II, will be used on the submarine Nautilus for which the keel was laid last July. It will be the first submarine to receive this revolutionary new type of power plant. In the ship, nuclear energy will be put to use for large-scale power utilization for the first time, resulting in an around-the-world submarine.

The second plant is a full-size

working model of a submarine atomic plant, while the third is another nuclear power plant many times larger than those mentioned above. It is planned that this power plant shall be suitable to power major naval vessels such as aircraft carriers.

GE INSTRUCTS SIGNAL CORPS MEN

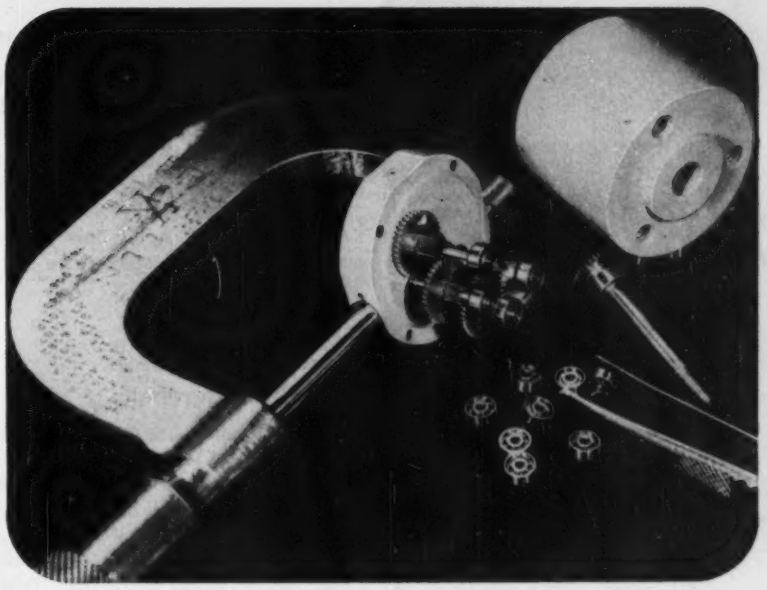


SERIES of month-long classes is conducted by General Electric to instruct Signal Corps technicians on the installation, operation and maintenance of microwave relay communications equipment. The company is producing the equipment for the Signal Corps at its Syracuse, N. Y. plant. Assisting instructor Gus Kandaris (right rear) is J. N. Craver (left rear), chief radio engineer for the Signal Corps plant engineering agency, who attended the class to further familiarize himself with the equipment

RTMA Launches Serviceman Program

A PROGRAM designed to improve the technical proficiency and business technique of radio-tv service technicians is being launched by RTMA with the institution of a pilot course in the New York Trade School.

The vocational training program, developed by the RTMA Service Committee under Chairman R. J. Yeranko of The Magnavox Co., has as its immediate objective the upgrading of television service technicians through existing vocational and trade schools. This is to be accomplished through the development and publication of manuals and teaching aids for schools and instructors which would reflect the recommendations of the radio-tv



Micro Bearings Measure Up

. . . in this high speed aerial camera gearbox

Made by Exact Engineering & Mfg. Co., Oceanside, California, the tiny gear box shown above is used to drive high speed aerial cameras in modern jet aircraft. Very small size and precision quality are required in every bearing for lowest possible friction, accurate positioning of shafts and minimum back lash in the gears. Assurance of long, trouble-free operation is also important, since battle area servicing is always a problem.

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Send today for Catalog No. 33 which gives full specifications and application data on all types and sizes of Micro Ball Bearings.

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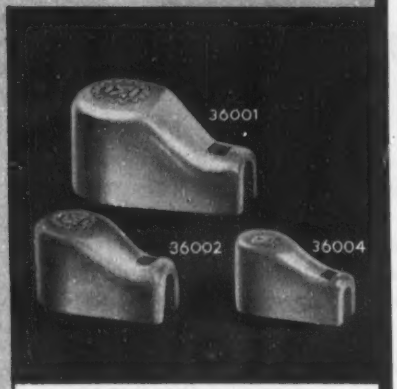

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A new addition to this series of exclusive Millen "Designed for Application" products is the 36004 for use on tubes with ¼" diameter contacts. Efficient, compact, easy to use and neat appearing. Soldering lug and contact one-piece. Lug ears annealed and solder dipped to facilitate easy combination "mechanical plus soldered" connection of cable. No. 36001 for 9/16" tube terminals. No. 36002 for ⅜". No. 36004 for ¼".

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industry and be consistent with the rapidly changing designs and products of the industry.

It is estimated that the radio-tv training program will require an industry subsidy of $80,000 for the first two years. After this period the program is expected to be self-supporting.

Cincinnati IRE Sets All-TV Conference

SEVENTH Annual Spring Technical Conference of the Cincinnati Section of IRE will be entirely devoted to television. It will be held in Cincinnati on April 18, 1953.

Following is the list of speakers and papers to be delivered: Television and the Bell System, by (speaker undetermined); A High Powered UHF-TV Broadcast System, by F. J. Bias of GE; The Design of TV Receivers Utilizing Non-Synchronous Power, by G. D. Hulst of DuMont; Approach to Mechanized Assembly of Electronic Equipment Applicable to TV Receivers, by L. K. Lee of Stanford Research Institute; The Selection and Amplification of UHF TV signals, by W. Boothroyd and J. Waring of Philco; Transient Considerations in the NTSC Color System, by B. S. Parmet of Motorola; A Four Gun Tube for Color TV Receivers, by J. Rennick and C. Heuer of Zenith; Latest NTSC Color System (Orange Cyan Wide Band), by R. D. Kell and A. C. Schoeder of RCA.

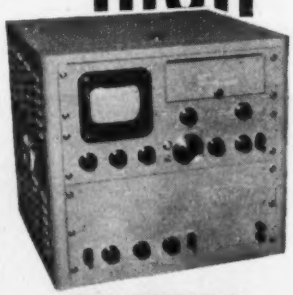
Reps Change Name

THE Representatives of Electronic Products Manufacturers, Inc. is the new name of the reps' organization formerly known as the Representatives of Radio Parts Manufacturers.

Electronic Parts Show Allocates Space

A TOTAL of 234 companies have reserved 374 display units for the 1953 Electronic Parts Show to be held May 18–21 at the Conrad Hilton Hotel in Chicago. It is estimated that 10,000 persons will attend the show.

A NEW HIGH



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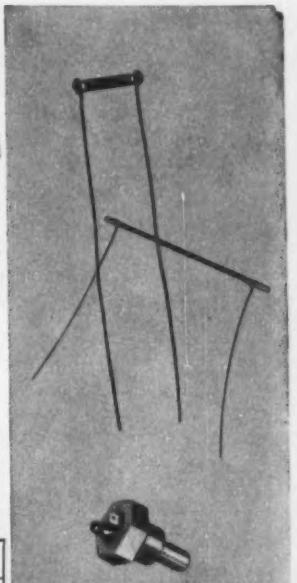

Used in this typical application for sensing the temperature of hydraulic oil.

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NEW BOOKS

Advances in Electronics

EDITED BY L. MARTON. *Academic Press, Inc., New York, New York,* 344 *pages,* 118 *illustrations,* 1952, $7.80.

THE remarkable group of books, of which this is the fourth, comprises a series of tutorial articles on subjects chosen annually by a distinguished editorial board. The choice of subjects displays a catholic interest, ranging from the manufacture of cathode-ray tubes to mathematical treatises on electron scattering in solids.

As the preface to the first edition states: "The 'Advances in Electronics' is a yearly publication devoted to the general field of electronics. The term 'Electronics' comprises both physical electronics and engineering electronics; namely the basic physics of charged particles, on the one hand, and the methods and instrumentation for employing such charged particles usefully."

Rather a conservative statement in the light of Dr. Everitt's recent definition!

The articles usually run from 25 to 75 pages, there being seven in this volume:—

1. Electron Scattering in Solids, H. S. W. Massey, F. R. S.
2. The Scintillation Counter, G. A. Morton.
3. Fluctuation Phenomena, Aldert van der Ziel.
4. Electronic Digital Computers, C. V. L. Smith.
5. Modulation of Continuous-Wave Magnetrons, J. S. Donal.
6. The Magnetic Airborne Detector, Winfield E. Fromm.
7. Multichannel Radio Telemetering, M. G. Pawley and W. E. Friest.

None of these articles is exactly easy reading since space limitations force the maximum of compression. Naturally the skill with which the selection and compression of material is effected varies from article to article. On the whole the quality is quite high. Mr. Fromm's discussion of the MAD system is particularly likable. On the other hand Mr. Smith's article on computers suffers from too much packing. It

could have been made much more readable with the increase of only a few pages.

The format of the books is attractive, the type easy to read, and typographical errors are few.

This series forms an excellent source of material for the research worker who wishes to broaden his interest and to keep abreast with advances in related fields.—KNOX MCILWAIN, *Hazeltine Electronics Corporation, Little Neck, New York.*

Applied Electronics Annual 1952

EDITOR, R. E. BLAISE. *British-Continental Trade Press Ltd., London. J. D. Griffiths, 3606-A Parkwood Dr., Greensboro, N. C., 240 pages, 1952, $8.00.*

A SERIES of short articles on the applications of electronics to industrial operations, such as in textiles, medical diagnosis, motor control and high-frequency heating, plus articles on germanium, magnetic recording, underwater television and new materials for components. In addition there is a list of trade and technical societies and manufacturers of radio and electronic apparatus and components throughout the world, a list of trade marks and names, wholesalers, importers, etc. Interspersed with the text are advertisements of the principal British manufacturers.—K.H.

Principles of Radar

By M. I. T. RADAR SCHOOL STAFF, *Third edition by J. F. Reintjes and G. T. Coate. McGraw-Hill Book Company, Inc., 985 pages, $7.75, 1952.*

THE SUBJECT matter of this book is an expansion and reorganization of the earlier editions of the book. The scope can be appreciated by listing of the chapter headings and number of pages devoted to each: Pulsed Radar (54 pp); Timing Circuits (99 pp); Modulators (62 pp); Indicators (62 pp); Synchros and Servomechanisms (61 pp); Receivers (130 pp); Radio Frequency Transmission Lines (77 pp); Waveguides (68 pp); Resonant Lines and Cavities (84 pp); High-Frequency

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DIRECT-READING R-F WATTMETER

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50 ohms

Triple Range 0-25 watts
0-100 "
0-500 "

Type N Input Connector
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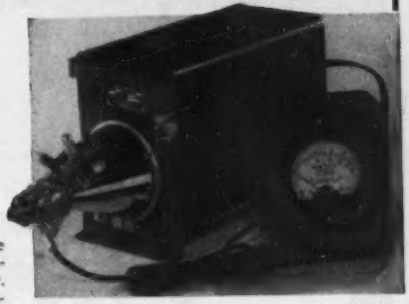

● Model 67 is a larger type Wattmeter than the well-known AN-ME-11/U (our Model 611) R-F Wattmeter. Specifically designed for fixed station transmitters to 500 watts output, it may be used nicely on low range for mobile gear. Provided with an aluminum cased, shock-mounted meter, Model 67 is as simple to use as a DC voltmeter. Now in general use throughout the industry, TERMALINE Wattmeters may be depended upon for fast, accurate and repeatable power readings

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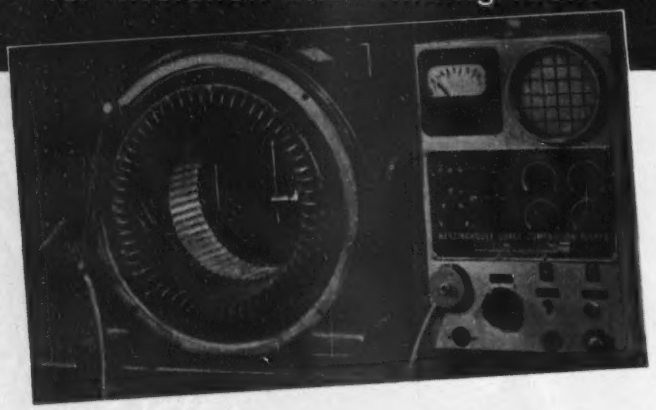

Westinghouse Surge Comparison Tester reduces production test time, permits positive results, fewer rejects—bringing substantial savings. This electronic device is designed to detect and locate insulation faults and winding dissymmetries in motors, generators, some types of transformers and coils. It operates quickly, simply, with fingertip control. Highly mobile and portable, it fits easily into production line techniques as well as repair shop. For more complete information, write Westinghouse Electric Corporation, I. E. Devices Section, 2519 Wilkens Avenue, Baltimore 3, Maryland.

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Triode Oscillators (48 pp); Klystrons and Magnetrons (60 pp); Radio-Frequency Transmitting and Receiving Systems (89 pp); Antennas (64 pp); Propagation (18 pp); and Index (8 pp).

The original purpose of this book was to serve as a text for a course in radar principles for Naval Officers. As such it provided an excellent basis for study to bring electrical engineers who had not had access to the classified war time developments into position to understand the principles of operation of current radar systems. Thus, in addition to specifically radar subjects, much general information is included on subjects such as transmission line and waveguide theory, servomechanisms and high frequency operation of vacuum tubes.

Now that the Navy course is discontinued, there exists some question of the need for this third edition inasmuch as the more general subject matter is at an intermediate level below that normally given to communication engineering students or needed as reference material for engineers working in the field. As a survey text, this third edition is excellently organized, clearly written and well illustrated. —G. J. LAURENT, *Research Division, Philco Corporation, Philadelphia, Pa.*

Photoelectric Tubes

BY A. SOMMER, *EMI Research Laboratories. Methuen & Co., Ltd., London; John Wiley, New York.* 1952, 118 *pages*, $1.90.

ANOTHER of the interesting and useful Methuen Monographs on Physical Subjects. In this second edition, care is taken to indicate that it deals with phototubes and not with photovoltaic or photoconductive cells. The new edition contains a new chapter on the theory of photoelectric emission, expanded material on multiplier phototubes and new material on image converter tubes.

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matching of light sources and photocathodes, vacuum and gasfilled tubes, multiplier phototubes and applications of all types of light-sensitive tubes.—K. H.

THUMBNAIL REVIEWS

ELECTRICAL MEASURING INSTRUMENTS, Part One, Second Edition. Revised by George F. Tagg, chief research engineer, Evershed and Vignoles, Ltd. 598 pages, $12.00, John Wiley & Sons, Inc., New York. A classic dealing with the design, manufacture and use of fundamental electrical instruments.

THE CHEMICAL ELEMENTS. By Helen Miles Davis, editor Chemistry Magazine. Science Service, 1719 N Street NW, Washington 6, D. C. 160 pages, 1952, $2.00. Basic information on the 98 elements and particles plus a periodic table plus some hitherto untranslated accounts of the discovery of certain elements.

THE MILITARY ELECTRONIC STUDY. By William C. Urlovic, Pacific Mercury Research Center, Santa Barbara, Calif. 23 pages, 1952, free. For anyone contemplating, or engaged in, research on any subject for the armed forces. The philosophy, technique and pitfalls of setting up an organization, estimating study time and costs, maintaining good relations all round.

RADIO AND TELEVISION WORKSHOP MANUAL. By Sidney A. Diamond, Boston University, and Donald M. Anderson, Massachusetts Department of Education. Prentice-Hall, New York, N. Y. 1952, 300 pages, large format, $4.50. A "how-to" book for those who wish to be successful in front of a microphone or camera. Dialog, rules, tricks, music etc.

COMPUTING METHODS AND THE PHASE PROBLEM IN X-RAY CRYSTAL ANALYSIS. Edited by Ray Pepinsky. X-ray Crystal Analysis Laboratory, Pennsylvania State College, State College, Pa. 1952, 390 pages, large format, $7.50. Proceedings of a Conference on the subject held at State College in April 1950 under the auspices of the Rockefeller Foundation, the Office of Naval Research and Pennsylvania State College. Twenty papers and nine appendices.

PHYSICAL FOUNDATIONS OF RADIOLOGY. By Otto Glasser, Edith H. Quimby, L. S. Taylor and J. L. Weatherwax. Paul B. Hoeber, Inc. (Harper & Bros.), 1952, 581 pages, $6.50. A new and thoroughly revised edition of a well known text which, in the first edition, went through eight printings. Gives the history of x-rays, technical aspects of the use of x-rays, dosage considerations and measurement of dosage, plus new material on usage of radioactive isotopes. Small handy format, very practical.

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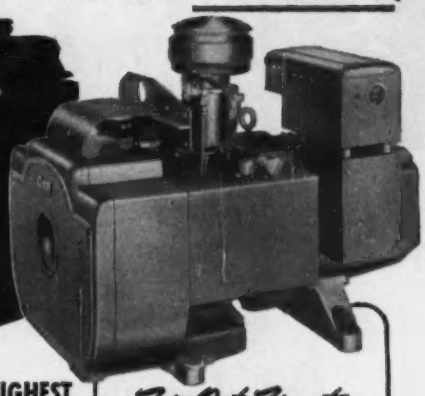

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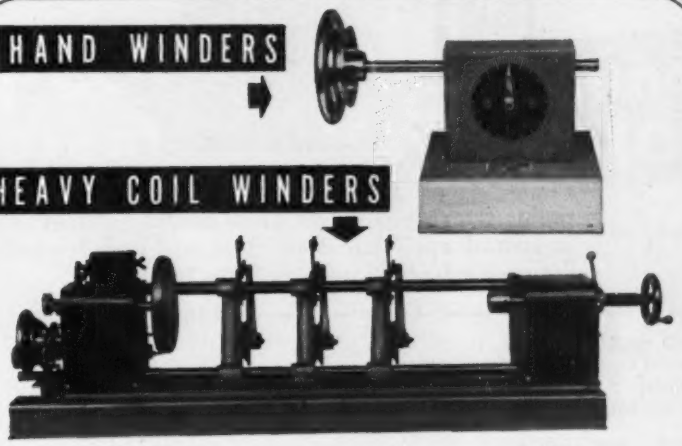

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BACKTALK

Smaller Necks

DEAR SIRS:
THE MEMORIES referred to in Frank Willey's letter in the November 1952 issue of ELECTRONICS (*Backtalk*, p 436) brought back others to this writer. Among the various ¾-inch neck tubes built in those days at General Electric was one for wide-angle deflection. It was of flat face and such short bulb length that it was promptly catalogued as the Squatron. We also successfully built tubes with neck stems of ⅝-inch outside diameter. For my "Museum" I have kept one of these with a 2-inch screen. Its deflection yoke, built for the occasion by S. Hansen, is in a ¾-inch cube.

C. H. BACHMAN
Department of Physics
Syracuse University
Syracuse, New York

Electronic Embalming

DEAR SIRS:
YOUR November, 1952 issue of ELECTRONICS (p. 98) carrying the excellent paper by Gale & Burrill on "Electron Beams Sterilize Food and Drugs" once again calls to my mind my earlier contention that Van de Graaf generators with scanned beam output operating at from 2 to 10 million volts could be used for human cadaver preservation—electronic embalming, if you will!

This rather gruesome approach was promulgated by this writer in 1944 while still an engineering student at Ohio State University. Unfortunately, the idea was received rather badly, not for technical reasons but because of the possible social objections to the plan. Practically the plan would be two-fold, destroying the bacteria extant in the tissues of the deceased and curtailing enzymic action which would otherwise permit degeneration of the cadaver tissue.

Embalming is a time-honored science going back thousands of years. Cremation is also an ancient alternate technique. Practiced among the Jews, temporary packing in ice while awaiting burial is the third popular method of han-

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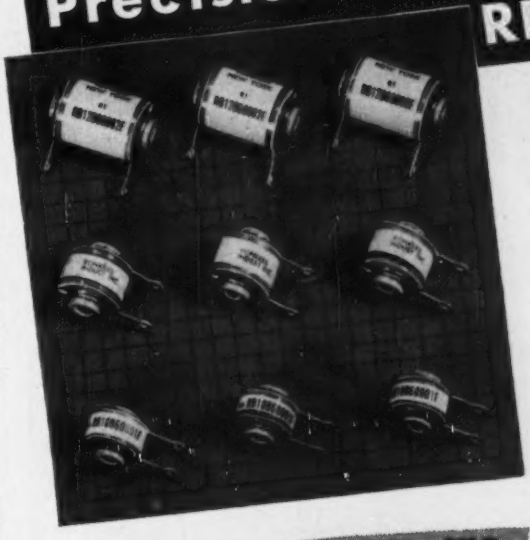

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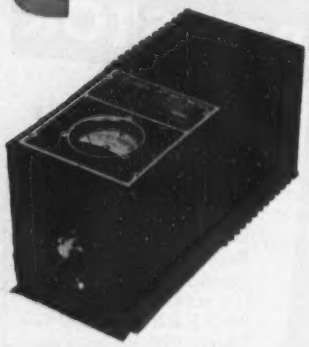

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It is my estimate that such embalming would permit the cadaver to remain without decomposition, alteration in appearance or odor up to two weeks without any other treatment.

DAVID GNESSIN
New Rochelle, New York

WWV's Accuracy

DEAR SIRS:

IN THE November issue of ELECTRONICS is an article entitled "Industrial Frequency Standard" by H. W. Kline (p 130), in which a crystal oscillator is not used, a locked oscillator being synchronized with WWV's received signal. While WWV's claimed accuracy, as transmitted, is 2 parts in 100 magacycles, their usual accuracy is perhaps twice this, or one part in 10^8.

However, due to the Doppler effect, caused by the motion of the ionized reflecting layer in the stratosphere, the accuracy of the received signal is, usually, only about 5 parts in 10^7.

This effect has been known for several years. See such articles as: A Standard of Frequency, *Jour. IEE*, Jul., 1946; High-Precision Frequency and Time Standards, *Proc. IRE*, Jan., 1950; and my own article in the Western Union *Technical Review* for Apr. 1952. Also in the first footnote of an article by A. W. Warner, in the Sept. 1952 *Proc. IRE*, he states, "There is no known method of communicating a frequency accurate to one part in 10^8 or better from one place to another hundreds of miles away: . . .".

Even land lines, microwave relays, or coaxial cables will have some variable phase shift, although less than the Doppler effect of skywave transmission. To see the ef-

fect of the Doppler effect, an independent standard of high accuracy must be available at the receiving end of the circuit. I think that a correction of the accuracy of this type of standard might be desirable.

L. W. FRANKLIN
Radio Research Division
The Western Union Telegraph Co.
New York, N. Y.

Dowsers

DEAR SIRS:
THE CORRESPONDENT who asked to have his name withheld concerning water dowsers need not be so cautious. There are quite a few scientists of good repute working in this most interesting parapsychics field today on a purely mechanistic and communications theory basis.

There is no witchcraft or supernatural effect involved, but some obscure magnetic, electric and infrared senses possessed by abnormally sensitive humans which are similiar to the uncanny homing, tracking and migrating senses of some animals. The water dowser's gifts appear to be related to the magnetic sense of homing pigeons and the infrared smell senses of insects. Endocardiographic readings taken by Prof. S. W. Tromp[1] indicate that nerve potential variations coincide with the magnetic and electric field variations about a dowser's body and the nerve reflex responses of his arm muscles and the divining rod. Running water is different from still water in that it develops a frictional electric charge which strongly effects a sensitive dowser's sensory motors. Bioelectrical fields have been measured at distances up to 15 feet from animals and plants.

Professor Tromp found that some dowsers got responses where there were no measurable currents, fields or radiations. This he eventually tracked down to abrupt changes in soil resistivity with geological equipment, according to a personal corespondence letter to the writer. Hence a dowser's body radiates either an electrical or infrared field and his fantastically sensitive nervous system picks up the tiny reflections from the soil boundary, which may also be a wet-soil bound-

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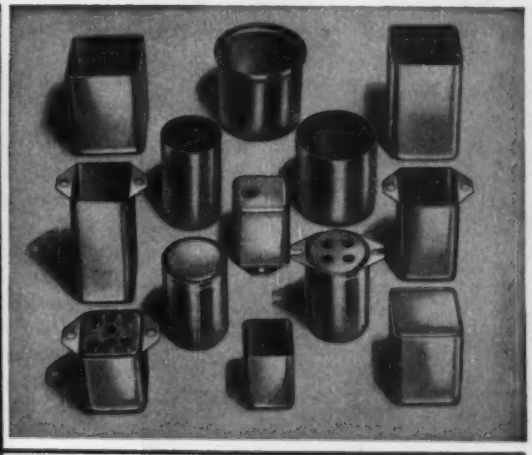

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ary caused by a body of water. For discussions of such biological phenomena, see the papers of Burr, Yeagley, Rhine, Ravitz, Puharich, Rajewsky, Reich, Cazamalli, Miles, Beck, Humphrey et al, and the books on dowsers by Maby, Tromp and Roberts.

The blind little bat, for instance, emits a triple-modulated sonar pulse to clock distance objects by timing the pulse echoes, and close objects by analyzing the a-m and f-m modulation beats, to extract a maximum of information from a restricted bandwidth of 40 to 70 kc, and has applied Shannon's information theory millions of years before man appeared on this earth. A casual study of so-called "psychics" indicates that Mother Nature may be even better an empirical-methods engineer in communications than in the bat's little sonar-computor-servo blind-navigation system.

T. POWELL
Great Neck
Long Island, N. Y.

REFERENCE

(1) S. W. Tromp, "Physical Physics," Elsevier Press, Holland and New York, 450 pages, $8.00, 1948.

More On Dowsers

DEAR SIRS:

THE AUTHOR of the unsigned letter on the subject of dowsing and electronics in the *Backtalk* column of ELECTRONICS, December, 1952, (p 398) is perhaps unaware that:

(1) Dowsers are not infallible. For example, H. B. Nichols, in the *Scientific Monthly*, May, 1951, p 340, states that in New South Wales the dowsing history of several thousands of water wells was recorded by the government, and that the dowsed wells were consistently less successful than the undowsed locations. From this it might appear that chance, or possibly that more rare quality, common sense, could be as effective as dowsing.

(2) Competent geophysicists and geologists are not completely unaware of electronics as applied to water-finding, and the subject has received some attention by C. A. Heiland, "Geophysical Exploration," Prentice-Hall, New York

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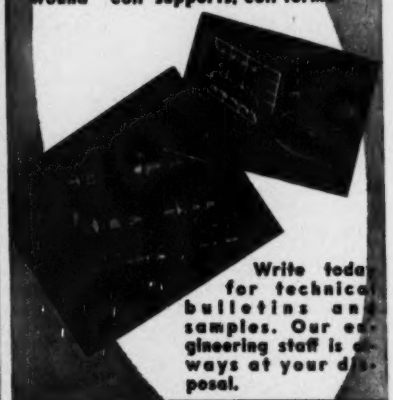

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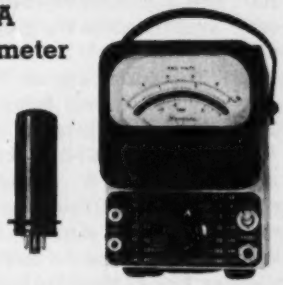

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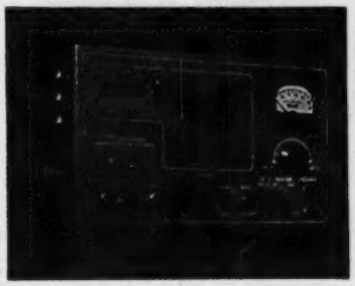

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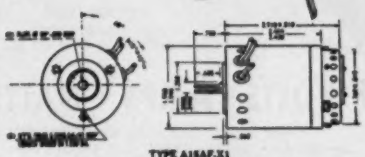

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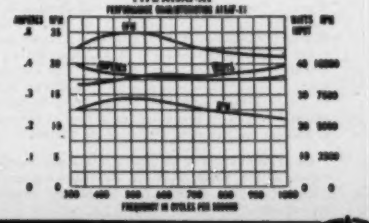

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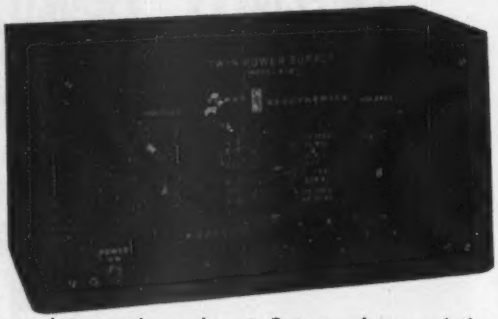

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1940, and by J. J. Jakosky, "Exploration Geophysics," Times-Mirror Press, Los Angeles 1940, and by other authorities in the geophysical field.

(3) The possibility of the dowser's nervous system being stimulated by changes in some external force or electrical field has been recognized by S. W. Tromp, "Phychical Physics, A Scientific Analysis of Dowsing, Radiothesia and Kindred Divining Phenomena," Elsevier Press, New York 1949.

(4) The controversial subject of dowsing has received much attention (possibly more than it deserves) by scientists and others, including Kenneth Roberts, novelist, "Henry Gross and His Dowsing Rod," Doubleday, New York 1951. More recent and brief, and with twenty-nine references, is, "Water Witching: An Interpretation of a Ritual Pattern in a Rural American Community," by E. Z. Vogt, in the *Scientific Monthly*, Sept., 1952, p 175.

(5) Ground water, hydrology and water supply engineering are, and have been receiving continuous and costly research from industry and government, and presumably a few "electronics boys" are available and working.

(6) Experts in electronics are also "scientists".

BISHOP & BISHOP
Cassopolis, Michigan

Why?

DEAR SIRS:

IS IT NECESSARY that we be bound down to relatively horse-and-buggy tolerances on tube limits as manufactured for the mass market when more and more applications these days are in the atomic-and-jet classification? Rather than gear our precise instrumentation to wide-tolerance vacuum tube limits, it seems to me that it behooves tube manufacturers to work toward narrowing down those limits to keep step with today's progress. Maybe that is impossible to accomplish at the present time, but the feeling persists that at least as much time and expense should be put in that direction as is used to educate the

user to wide tolerances.

The special industrial and ruggedized series is a step in the right direction, except that they add just so much more to the confusion by bearing rouges' gallery numbers that bear absolutely no relation to anything—thus very successfully hiding their identify from the user and adding another to the already-too-long list of types to remember.

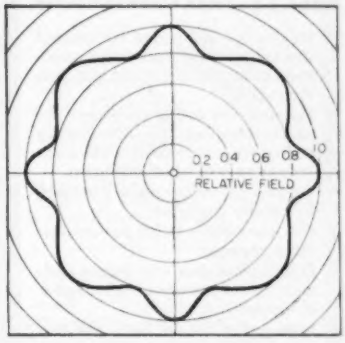
Even in the mass-produced home market, the use of the wide-tolerance tubes means engineering and servicing headaches.

Why cannot we clean house somewhat on both the ever-growing list of tube types and the thinking to back it up and assure that progress goes forward rather than being tied down to old-fashioned ideas?

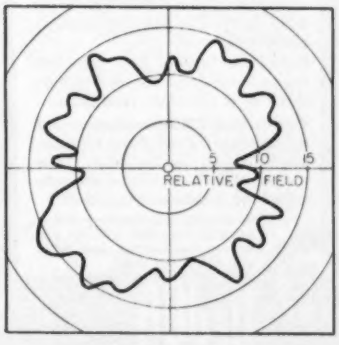
PHILIP C. TAIT
Emeryville, California

Calculated Curves

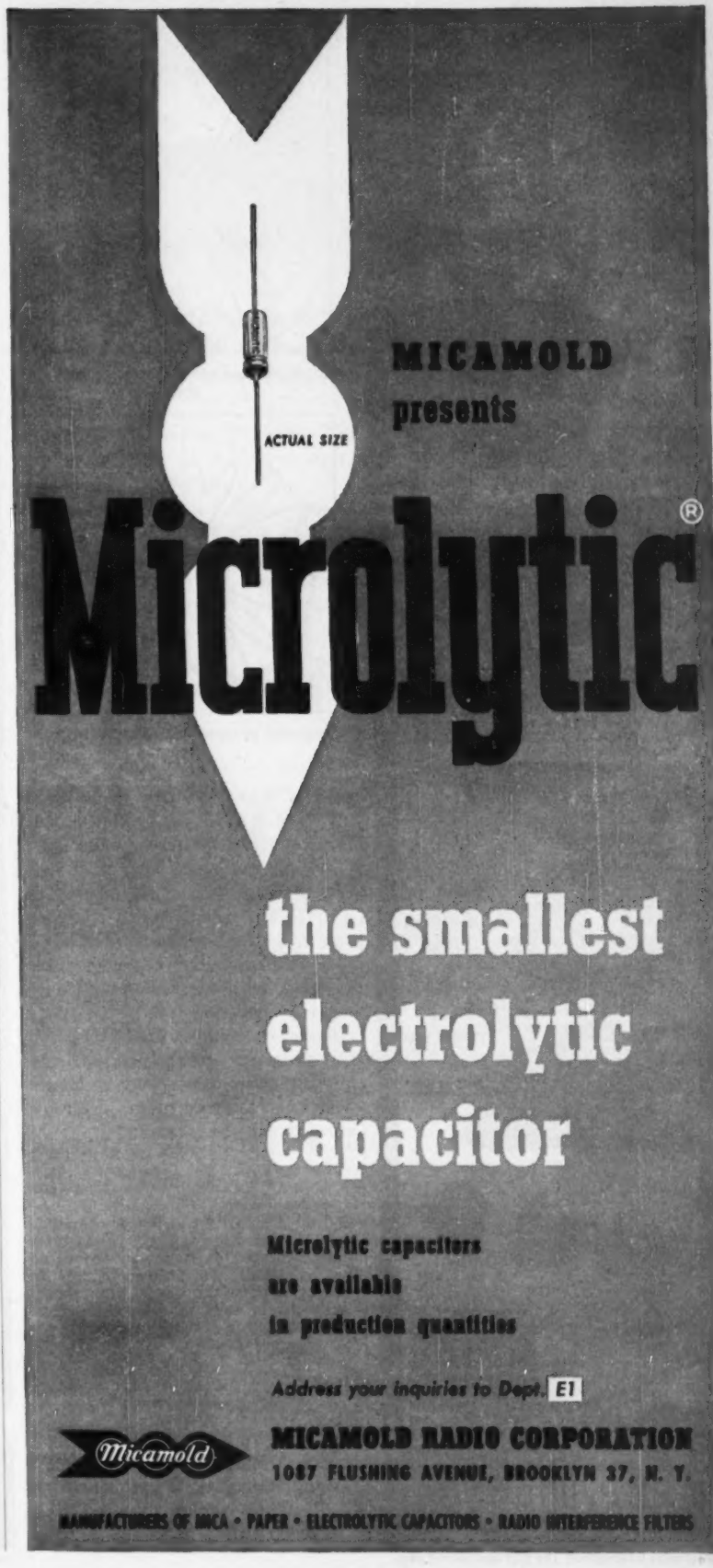
DEAR SIRS:
I WAS not very happy to see that you had to omit two calculated curves of antenna patterns in my



Calculated patterns for 90-degree skewed antenna



Measured pattern for 90-degree skewed antenna



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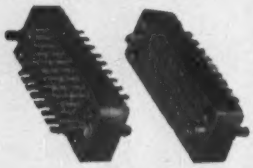
CONTINENTAL

MINIATURE *Precision* CONNECTORS

SERIES 20

RACK TO PANEL TYPE

4 to 100 contacts



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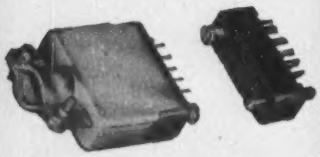
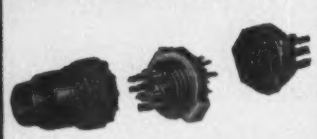
CABLE TO PANEL TYPE

4 to 100 contacts



VOLTAGE BREAKDOWN (Sea level normal humidity) .....3600 V. RMS
CURRENT RATING .....5 AMPS
CONTACT SIZE ..... 20 AWG wire
EFFECTIVE CREEPAGE ..... ⅛ in.
MECHANICAL SPACING.....5/64 in.

CABLE TO PANEL TYPE



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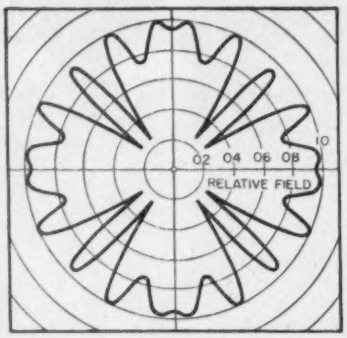
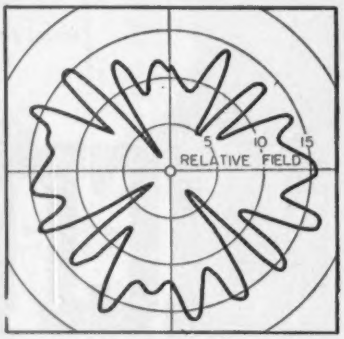


Calculated pattern for antenna without skew



Measured patterns for antenna without skew

article, "Skewed Antenna at WJZ-TV" which appeared in the October issue of ELECTRONICS on page 130.

Among engineers it is quite well accepted to measure the success of a project by the correlation of calculated and measured work. In this case the measured patterns differ so much without the calculated results to substantiate these wide differences, there is reason to doubt the propriety of the work in the no-skew case. It is easy to obtain poor curves by an error in circuit arrangement or phasing.

M. W. SCHELDORF
Andrew Corporation
Chicago, Illinois

(Editor's Note: In order to show the close correlation between measured and calculated patterns, as requested by the author, we are reprinting the measured patterns below, along with copies of the calculated patterns that were omitted in editing the article.)

NIM

DEAR SIRS:

WE NOTE in the November, 1952 issue of ELECTRONICS the article "Digital Computer Plays NIM" (p 155), which brings to mind that The North Electric Manufacturing

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New RUGGEDIZED D.C. *Instruments*

2½" MODEL R-210

3½" MODEL R-310

MEETS MIL-M-10304

- Mechanism suspended by internal live rubber ring mounts for maximum shock displacement and protection.
- External live rubber grommet for shock mounting with interlocking part of front bezel eliminates glass breakage and bezel distortion.
- Water-tight seal to panel provided by rubber grommet.
- Glass to metal seal for perfect hermetic sealing.
- Drawn steel case with heavy cadmium plate provides high degree of magnetic shielding.
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- Rugged glass-to-metal seal terminals withstand a 3000 volt breakdown test under extreme humidity conditions.
- Entire mechanism has complete ruggedized construction for high shock and vibration resistance.

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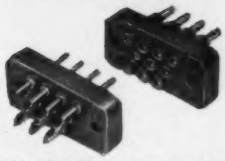
CONTINENTAL

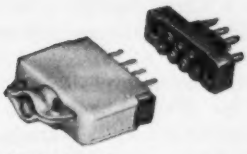
MINIATURE
Power
CONNECTORS
SERIES 14

RACK TO PANEL TYPE
7-9-10-15 CONTACTS



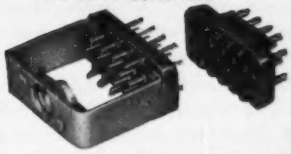
SERIES 14 FOR #14 AWG WIRE
These precision power connectors were developed to employ the same electrical and mechanical properties as our series 16 but were reduced by 25% in height with a larger solder cup for #14 AWG wire.
The disengagement force is also considerably reduced.

CABLE TO PANEL TYPE
7-9-10-15 CONTACTS



SPECIFICATIONS
MAXIMUM WIRE SIZE...#14 AWG
Creepage between contacts 7/32" MIN.
Air Space between contacts 3/32" MIN.
Breakdown voltage between contacts with connector engaged at sea level, normal conditions.....5500 V.R.M.S.

CABLE TO PANEL TYPE
7-9-10-15 CONTACTS



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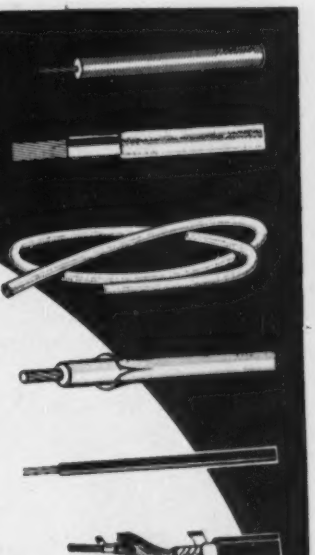

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  Solid Colors or Spiral Markings
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  MIL-W-5086 (Supersedes AN-J-C-48a)
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- JAN-C-76 WL-GLASS BRAID
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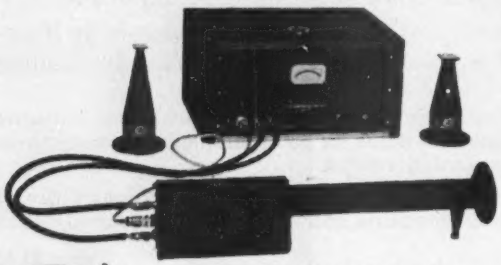
$P = \frac{E^2}{R}$

a direct reading calorimetric wattmeter

* Eliminates necessity of all calculations.



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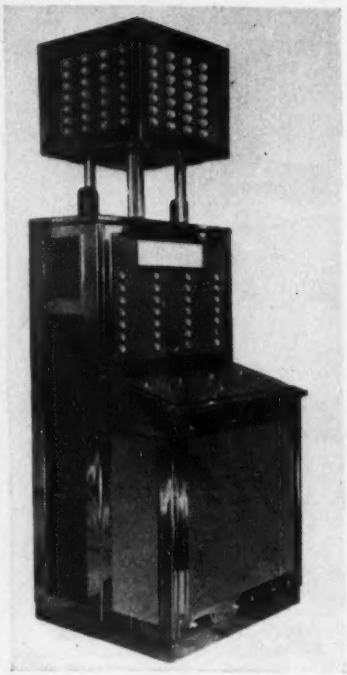

Relay-operated Nimatron played faultless NIM as early as 1940

Company built a similar machine in 1940. While it operated on relay principle only, the results were the same.

This machine was designed and built for Westinghouse and was displayed in the 1940 World's Fair in New York. It was also described in the August 1940 issue of *Popular Mechanics*.

This machine was known as a "Nimatron". We believe the machine is still on display in the Planetarium at Pittsburgh. The photograph shows the front of the machine, with four rows of seven lights and the operating buttons. The queue on the top merely repeated all of the lights in four directions. In the event the player won the game, a small token was delivered in the slot, lower center, front.

There were four counting chains which operated with the lights in each row and compared the powers of two to determine which play was winning. There was also an additional counting chain which kept track of the number of games and set up nine different starting combinations. All starting combina-

tions were arranged so that the player could win if he did not make a mistake. However, once a mistake had been made, the machine took over and would never lose from that point. In cases where the player had a winning combination, the machine made random plays extinguishing one, two or three lights in rotation, the idea of this being to eliminate memorizing previous plays. This arrangement, together with the nine different starting combinations, gave an infinite number of plays, so that a previous winning combination would be very difficult to memorize and retain.

We thought perhaps you might be interested in knowing that this type of machine had been designed and manufactured at least twelve years prior to your publication of a similar machine designed by Maxson Corporation.

ERIC BROOKE
Chief Engineer, The North Electric Mfg. Corp., Galion, Ohio

Zero and Negative

DEAR SIRS:

THIS REFERS to "Zero Impedance" in the *Backtalk* department of ELECTRONICS, p 385, May 1953.

Attention of your correspondent and readers is hereby drawn to my article "On Voltage Stabilizer Circuits" in the April, 1942 issue of the *Indian Journal of Physics*. Certain innovations for obtaining zero or negative internal resistance and others for perfect and more than perfect negative stabilization has been described there. I believe that is the first publication on stabilizer circuits giving satisfactory methods of obtaining readily these unusual performances. In their classic work published in *Rev. Sci. Instr.* in 1939, Hunt and Hickman have only made an observation (on the basis of a mathematical study of the effect of source resistance on the performance of stabilizers) that zero or negative internal resistance may be shown by a stabilizer having negative stabilization when working off a primary source of high internal resistance.

The usual two-valve stabilizer circuit cannot give five perfect stabilization—the change in output voltage dV_o can never become zero for a change dV_i in the input volt-

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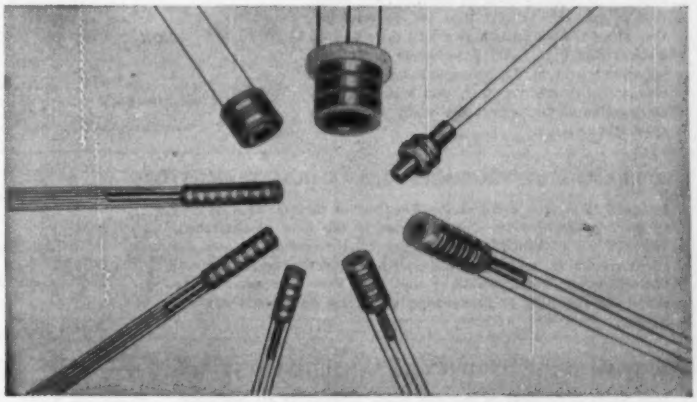

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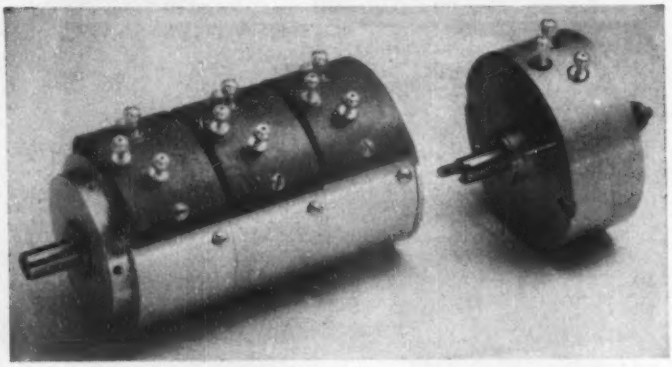

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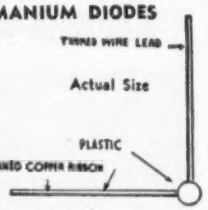

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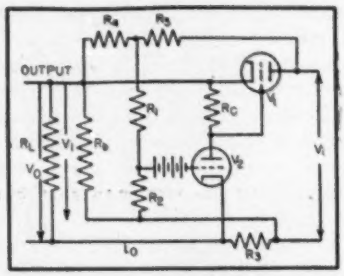

Circuit of zero or negative impedance power supply regulator

age although it may be very small in comparison. The very nature of operation of these circuits demand the presence of some control voltage at the grid of V_2. This control voltage is furnished by the change in the output voltage dV_o in the usual two-tube circuits. However the necessary control voltage may be easily supplied from the varying input voltage. In that case, no additional change in output voltage will be necessary to provide extra control and in this sense the circuit may be said to give perfect stabilization.

The circuit I developed is shown in the diagram.

The resistance R_s between the cathode of V_2 and the negative line in the circuit brings about negative internal resistance in two-valve voltage stabilizer circuits. A simple analysis gives the internal resistance defined by the relation

$$R_o = -\left(\frac{\delta V_o}{\delta I_o}\right)_{V_i} \text{as}$$

$$R_o = \left[\frac{1}{GA\beta} - R_3\left(\frac{1}{\beta} - 1\right)\right]$$

where G is the mutual conductance of V_1; A, the amplification given by V_2 and $\beta = R_3/(R_1 + R_3)$

It will be seen that by a suitable choice of the value of R_s, one can make the internal resistance zero or negative. A negative value of several hundred ohms is not difficult to attain.

The stabilization factor of the circuit remains practically unaffected by the inclusion of R_s and is approximately given by $S_o = \beta A\mu$ where μ is the amplification factor of V_1.

B. M. BANERJEE
Institute of Nuclear Physics
Calcutta, India

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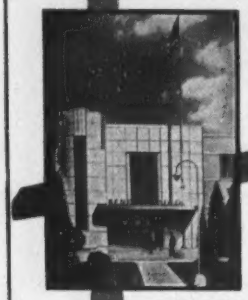

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Positions available at various levels of engineering achievement.

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Design of mechanical and electrical components and chassis in UHF and microwave systems

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COMMERCIAL AUTOMOBILE RADIO
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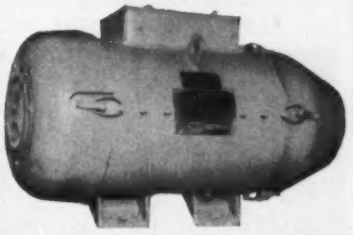

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AVAILABLE FOR IMMEDIATE DELIVERY

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Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0.5 MIN. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 384 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries.

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Unit of U. S. Navy TCK-7 Transmitter
Motor: 2 H.P., 230 V.D.C., 10 amps.
Generator: 1800V, D.C., 0.4 A, 500V, D.C., 0.35A. 115 V.D.C., 1.5A, 12 V. D.C. 2A. 3480 R.P.M. Self excited. Brand new including spare armature $365.00

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Western Electric D-163781 Plug-in.....$4.95
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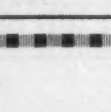

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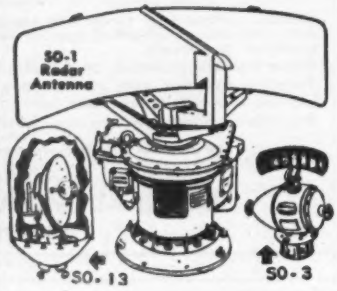
2. MFD 6,000V DC.....$14.50

RADAR EQUIPMENT



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Type SO-3 (3 CM.) Surface Search type with reflector, drive motor, etc., but less plumbing. New in original cases $189.50
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Provides 4 Types of Presentation:
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Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
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Gov't Cost $1800.00.
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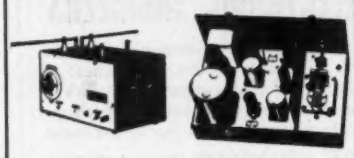

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Type BC-423-B, or tweeter, is a miniature keying unit, modulator and transmitter combined. A dipole mounted atop the tweeter case radiates a signal pulse at 205 megacycles modulated by pulses occurring at 4,098 CPS. Uses 2-6J7, 1-6F6, 1-955, 1-5W4 tubes. Operates from 115V. 60 cy. source. Brand new including tubes and instruction book....$29.50

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KVA .9458-520P Volts 460/345/200/115. New $4.50
FILAMENT—400/2600 CPS. Input—0/75/80/85/105/115/125V. Output—5V3A/5V3A/5V6A/6.3V 0.5A. No. 7249010—New $1.95
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TU-58 tuning unit (110-370MC).....$85.00

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Western Electric—type CR-1A/AR in holders. ½" pin spacing. Ideal for net frequency operation. Available in quantities. 5910-6350-6370-6470-6510-6610-6670-6690-7270-7350-7380 - 7390 - 7480 - 7580-9720. All fundamentals in KC. Good multipliers to higher frequencies .....**$1.25 each**

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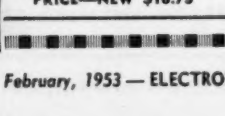

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GE Servo type 2CV1C1 400 cycle
Constant Output Line BC-730C
Synchro Amplifiers for Radar
Intercommunication type BC-605

ANTENNAS

MR-162 Coast Guard 23½ ft. whips
AS-33 APT-2, AT-38A/APT, AS-62/APS-13
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TDY RADAR JAMMER HORNS
PARABOLOIDS, MAGNESIUM DISHES 17½" dia.
SCR-633-A (part of BC-153-B Antenna)
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Type 2CV1C1

Brand New $29.50
Metal Dust Cover Included

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Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, P.E. 94CM dynamotor. Brand new equipment with instruction manuals.

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Sylvania 1N21B. Individually boxed and packed in leaded foil.
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Switch Micro R-RL2T. . . . . $.65
Switch Navy Rotary #647491. . . . . $17.50
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MICRO-SWITCH

S.P.ST NORMALLY CLOSED

BRAND NEW $.85 EACH

LINEAR SAWTOOTH POTENTIOMETER

W.E. No. KS 15138

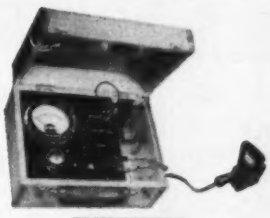
The d-c potentiometer consists of a closed type die-cast aluminum alloy frame consisting of a continuous resistance winding to which electric power is supplied through two fixed taps 180 degrees apart. Two rotating brushes (180 degrees apart and bearing on the resistance winding) and two take-off brushes are provided for the output voltage. Varying the position of the brushes varies the output voltage in accordance with a linear sawtooth wave. The potentiometer is excited with 24-volt direct current, is arranged for panel or bracket mounting, is approximately 3-11/16 inches in diameter, 3 inches deep, 4¾ inches long, and has an approximate weight of one pound. External connections are made through a standard AN type connector.

Brand New. $5.75

RADAR EQUIPMENT

Model S.Q. 10CM Portable Radar Set. Operates on 90-130 volt, 60 cy., 1 Phase. Presentation: A, B and P.P.I. Complete with tech. manual and full set of spare parts.

Model ASG-1 Radar with Parabola.
S.O.-11 Modulator unit.
Pulse Timer units for SD5 Radar.
Radar Crystal units—Raytheon 98.35kc.
S.O. Radar Accessory Control Panels.
S.O. Transmitter-Receiver units.
S.O. Radar Bearing Control Units.
Spare Parts Kit for S.Q. Radar.



FLUXMETER

Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1⅛". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at $29.50

AN/APA-10 POWER SUPPLY

Input:
80 or 115 volts
400 to 2600 cycles

Output:
1200 volts D.C. at 1.5 MA.
400 volts D.C. at 130 MA.
Includes tubes; 1—5R4GY, 1—2x2, 1—6AK5, cathode ray tube socket, resistance capacitance filter, two focus controls, an intensity control and 6AK5 reinserter circuit. Brand new.
Complete $13.75

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change

REPAIR PARTS FOR BC-348 RECEIVERS (H, K, L, R, Only)

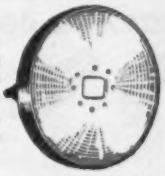
Also BC 234 Models P. K., Coils for ant., r.f., det., osc., I.F., c.w. osc., xtal filters, 4 gang cond., front panels, dial assemblies, vol. conts., etc. Write for complete list and free diagram.

AUTO TRANSFORMER

G.E. 400 cy. Cat. No. 80G184 K.V.A. .9458—.820P Volts 460/345/230/115 New $4.50

PARABOLOIDS

17½" diameter, spun magnesium dishes, 4 inches deep. Reinforced perimeter. Two sets of mounting brackets on rear. Opening at apex for waveguide dipole assembly 1½ x 1⅝".



BRAND NEW. . . . . PER PAIR $12.50

G. E. BATTERY CHARGER

Charges 54 cell battery at from 1 to 10 ampere rate

Input 115V., 60 cy. 1 Phase.

The model 6RC89F16 Copper Oxide battery charger consists of a transformer, a secondary reactor, a copper oxide rectifying element, a ventilating fan, control circuits and auxiliary equipment necessary for proper operations. Transformer tapped for various supply voltage. Eight secondary taps for adjusting changing rate. Built into metal cabinet. Metered.

Complete with spare fan and fuses. New in original packing cases. Shipping weight approx. 305 lbs.

Price $255.00

RELAY

Clare octal base Relay No. 30FMX 115V. 60 cy. 0.140 amp. Res. 75 ohms. Makes two breaks one.

Brand new $2.45

RADAR REPEATER ADAPTERS

NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. installations. The equipment contains its own D.C. power supply; 115 Volts, 60 cycles A.C. from ships' power supply line is required for operation. Dimensions are 31½ x 21 x 15 in.

Description:

A: Output Video Signal Lines.
B: Output Trigger Lines:
C: Video Amplifier Bandwidth. less than 3 db down at 5mc.
4 lines at +2 volts amplitude.
4 lines at +30—+65V. Amplitude.
Flat within 1 db from 60 cy. to 3.5mc.
Uses 8—6AG7, 1—0D3, 3—6SN7, 2—6R4GY.
Full details on request.

24V DC SOLENOID

2 LB. PULL—¾" STROKE

BRAND NEW $1.45 Each

ELECTRONICRAFT INC.

27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

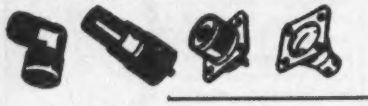
OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price
2	400	$ .58	.1	1500	$ .69	1	6000	$9.95	1	25KV	$85.00
5-5	400	1.65	.5	1500	1.25	.1	7000 R'd	1.79	.001	50KV	24.50
1	600	.85	1	1500	2.50	.1-.1	7000	5.95	.025	50KV	42.50
2	600	.69	4	1500	2.95	.1	7500	2.85	.2	50KV	85.00
2	600 R'd	.69	.1-.5	2000	.95	.075-.075	8KV	6.50	.25	50KV	95.00
2-2	600 R'd	1.65	.25	2000	1.50	1	10KV	29.50	7.5	220VAC	1.95
3	600	.98	.3	2000	1.30	.1	12KV	8.95	1-3	330VAC	1.95
4	600	1.65	1	2000	1.95	1	15KV	45.00	10	330VAC	3.95
4	600 R'd	1.65	2	2000	3.75	.045	16KV	4.79	12.75	330VAC	4.10
5	600	1.75	12	2000	8.95	.05	16KV	4.95	15	330VAC	4.50
6	600	1.85	1	2500	2.75	.075	16KV	8.95	5	440VAC	3.10
8	600 R'd	1.85	1-1	2500	3.85	.25	20KV	19.95	2.9	660VAC	3.50
8-8	600	1.95	.32	2500	15.50	1	20KV	54.00	7	660VAC	4.25
4-4-4	600	2.50	.5	3000	2.48				8	660VAC	4.50
4 x 3	600	2.50	1	3000	3.60						
10	600	3.25	2	3000	4.50						
1	1000	.65	.03	4000	1.25						
2	1000	.98	3 x .2	4000	2.95						
2	1000 R'd	.95	2	4000	6.95						
3.5-.5	1000	1.85	.1	5000	1.60						
4	1000	1.95	.2	5000	2.50						
4	1000	2.50	1	5000	4.85						
8	1000	3.25	2	5000	18.50						
1	1200	.85	5	5000	29.50						
1-1-1	1200	1.85	.01-.03	6000	1.65						

OILMITES

MFD	VDC	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-641	.85

COAXIAL CONNECTORS



83-1AC	$ .42	83-1RTY	$ .65	83-22R	$ .68
83-1AP	.30	83-1SP	.45	83-22SP	.60
83-1F	1.10	83-1SPN	.50	83-22T	1.95
83-1H	.12	83-1T	1.30	83-168	.12
83-1HP	.22	83-2AP	1.95	83-185	.12
83-1J	.72	83-22AP	1.40	83-765	.24
83-1R	.40	83-22F	2.10	83-776	.65
		83-22J	1.40		

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS
IN STOCK
UHF—N—PULSE—BN—BNC

UG-7/AP	$6.30	UG-22C/U	$1.20	UG-37/U	$17.50
UG-12/U	.95	UG-23/U	1.20	UG-57B/U	1.70
UG-15/U	1.25	UG-23B/U	1.50	UG-58/U	.70
UG-18/U	1.25	UG-23C/U	1.10	UG-58A/U	.90
UG-18B/U	1.05	UG-24/U	1.30	UG-59A/U	2.15
UG-19/U	1.60	UG-25/U	1.35	UG-83/U	1.75
UG-20B/U	1.60	UG-27/U	1.25	UG-85/U	1.60
UG-21/U	.85	UG-27A/U	2.25	UG-86/U	2.25
UG-21A/U	1.50	UG-28A/U	2.95	UG-87/U	1.40
UG-21B/U	1.00	UG-29/U	.95	UG-88/U	.90
UG-21C/U	1.05	UG-30/U	2.30	UG-89/U	1.10
UG-22/U	1.30	UG-34/U	9.75	UG-90/U	1.15
UG-22B/U	1.20	UG-36/U	12.50	UG-98/U	1.85
UG-102/U	$.80	UG-176/U	$.12	UG-255/U	$1.95
UG-103/U	.68	UG-177/U	.24	UG-260/U	.85
UG-104/U	1.40	UG-185/U	.95	UG-261/U	1.10
UG-106/U	.15	UG-191/AP	.80	UG-262/U	1.10
UG-108/U	2.60	MX-195/U	.75	UG-273/U	1.45
UG-109/U	2.60	UG-197/U	2.80	UG-274/U	2.30
UG-146/U	1.95	UG-201/U	1.95	UG-275/U	5.50
CW-159/U	.60	UG-203/U	.65	UG-276/U	2.75
UG-166/U	32.50	UG-206/U	1.45	UG-290/U	.90
UG-167/U	3.75	UG-224/U	1.15	UG-291/U	.95
UG-171/U	2.25	UG-236/U	3.85	UG-306/U	2.65
UG-173/U	.35	UG-245/U	2.25	UG-414/U	1.95
UG-175/U	.12	UG-254/U	2.75	UG-625/U	1.00

QUOTATIONS UPON REQUEST ON ANY CONNECTORS NOT LISTED HERE

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201

93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-13/U	$216.00	RG-26/U	$475.00	RG-57/U	$325.00
RG-6/U	180.00	RG-17/U	650.00	RG-29/U	50.00	RG-58/U	60.00
RG-7/U	85.00	RG-18/U	900.00	RG-34/U	300.00	RG-58A/U	70.00
RG-8/U	100.00	RG-19/U	1250.00	RG-35/U	900.00	RG-59/U	60.00
RG-9/U	150.00	RG-20/U	1450.00	RG-54A/U	97.00	RG-62/U	75.00
RG-9A/U	275.00	RG-21/U	220.00	RG-55/U	110.00	RG-77/U	100.00
RG-10/U	240.00	RG-22/U	150.00				
RG-11/U	100.00	RG-22A/U	285.00				
RG-12/U	240.00	RG-24/U	675.00				

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

2 ϕ LOW INERTIA SERVO MOTORS

KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50
PIONEER—10947-2-A 26 volt 400 cycle with 40:1 reduction gear $10.50
PIONEER—CK 13 115 volt 400 cycle—includes damping signal generator (autosyn) $47.50

HIGH VOLTAGE TRANSFORMERS

G.E.—Pri. 115V 60 cy. Sec. 6250V 80 MA—12.5 KV insulation $18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV insulation $18.50

ANTENNAS

AT-4/ARN-1 ..... $ 8.25
AT-38A/APT (75 to 400MC) 13.70
AT-49/APR-4 (300 to 3300MC) 13.70
AN-65A (P/O SCR-521) 1.50
AN-66A (P/O SCR-521) 1.75
A1A-3CM conical scan 125.00
ASB Yagi—5 element 450 to 560MC 9.60
ASB Yagi—Double stacked 6 element 14.70
ASA Yagi—Double stacked 370 to 430MC 29.40

RELAYS

Sigma type 4AH—2000Ω 4 ma DC coil—SPDT contacts—hermetically sealed 5 pin plug-in base $3.30
Stevens Arnold type 171 Millisec relay—600 ohm coil SPST NO contacts $5.50
Cutler Hammer and Square D type B-7A contactor—24 VDC coil—SPST NO 200 Amp contacts $4.75
Price Bros. type 161-M—220 VAC contactor—SPST NO double bk 30A contacts $3.25
G.E. CR5181-1A6—115 V 60 cy. AC contactor—(PST 30 Amp contacts plus two auxiliary SPDT contacts $14.50
RBM—115 V 60 cy. AC coil—DPDT 3 amp Contacts $3.20

METERS

1 MA DC 3½" R Dejur Mod 310 (0-4KV scale) $5.75
500 Microamps, DC—2½" round—Sun 4.30
1ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R.—General Electric 2.95
5 amp. AC 4" R.—JBT 4.11
30 V DC 2½" R.—General Electric 3.95
3 amp. RF 3½" R.—Weston 6.00

CRYSTAL DIODES

1N21	$1.19	1N27	$1.79	1N41	$11.25
1N21A	1.69	1N31	8.10	1N42	18.75
1N21B	3.50	1N34	.66	1N45	.94
1N22	1.09	1N34A	.95	1N52	1.05
1N23	1.95	1N35	1.70	1N53	3.15
1N23A	3.25	1N39	6.25	1N60	.55
1N23B	4.25	1N40	10.60		

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
50	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"	$1.25 each	

DUAL "J" POTS.—$2.95 ea.

50 SS	330 SS	2500 SS	2.5 meg SS
100 SS	500 SS	10K SS	5 meg SS
250 SS	1K SS	1 meg SS	1K/25K ⅝"

TRIPLE "JJJ" POTS.—$3.95 ea.

100K/100K/100K ⅝" 20K/150K/15K ⅝"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.86 EACH
TS-10 Type Handsets $9.25

GENERATORS AND INVERTERS

Eclipse-Pioneer type 718-3A (Navy Model NEA-3A) Output-AC 115V 10.4A 800 to 1400cy. 1ϕ; DC 30 Volts 60 Amps. Brand new $38.50
Eclipse-Pioneer type 1235-3A. Output-30 Volts DC 15 Amps. Brand New-Original Packing $15.50
PE-109 Inverter—13.5 VDC to 115 VAC 400 cy 175 VA 1ϕ (new) $79.50
PE-218 Inverters 28 VDC to 115 VAC 400 cy 1500 VA. (New) $49.50
Pioneer Type 800-1B Inverter-28VDC to 120V 800 cy 7 amp AC (used) $22.65
G. E. Inverter-28 VDC to 120 VAC 800 cy 750 VA 1ϕ $39.50
ATR Inverter 6VDC to 110 VAC 60 cy 75W $22.95
PU-7/AP Inverter-28 VDC to 115 VAC 400 cy 2500 VA (used) $75.00
Eclipse-Pioneer type 12121-1A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3ϕ 400 cy 250 VA 0.7 PF—(New) $225.00

TEST EQUIPMENT

- Gen. Radio 475B Frequency Monitor $200.00
- Gen. Radio 681A Freq. Deviation Meter 87.50
- I-72K Signal Generator 48.50
- Dumont 175A Oscilloscope 225.00
- Gen. Radio 757-P1 Power Supply 27.00
- A. W. Barber Labs. VM-25 VTVM 86.00
- TS-10A/APN Delay Line Test Set 45.00
- TS-19/APQ-5 Calibrator 185.00
- CWI-60AAG Range Calibrater for ASB, ASE, ASV and ASVC Radars 39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC 11.75
- 3 CM Pickup Horn Antenna AT-48/UP 9.95
- I-138A Signal Generator—10 cm 185.00
- BC-221 Frequency meter 125.00
- CW—60ABM Frequency Meter—10 CM 97.50
- Weston Model 1 D.C. Milliameter 150/1500 MA with leather case 75.00

MISCELLANEOUS EQUIPMENT

AN/APA-23 Recorder $147.50
I-82F Selsyn Indicator 6.95
SCR-515 compl. w/dynamotor control box 69.50
Amperex 1898 Gamma Counter 9.87
Powerstat 1226—115/230V Input—0-270V out. @ 9 amp 37.00
EIMAC-35T Ionization Gauge 3.95
FL-8 1020 cycle filter 2.95
RM-29 remote control unit 8.95
RM-14 remote control unit 8.95
RTA-1B 12/24V dynamotor 40.00
BC-1206-CM2 Receiver 12.95
ASB-4 Radar equip. Complete 69.75
RCA AVR-15 Beacon Recvr 18.50
Navy DP-14 Direction Finder complete 385.00
CU-24/ART-13 Antenna Loading Cond 4.95
T-85/APT-5 300-1600 MC Transmitter 175.00
PP-104/APT-5 Rectifier Unit for above 42.50
Sola #30807 Constant Volt. Transf. 250 VA 49.00
BC-1016 Tape Recorder 350.00
AN/APA-30 ..... 375.00
BC-910A Oscilloscope 147.50
BC-1068 Receiver 57.50
ATI and ATK TV Block Equip ..... Quote
BC-348 Receiver ..... Quote
RTA-1B Transceiver ..... Quote
T-47/ART-13 Transmitter ..... Quote
Sperti 1521 vacuum relay switch 9.50

PULSE TRANSFORMERS

UTAH 9262, 9278, 9280

UTAH 9318, 9340, 9350

G.E. K341318	Westinghouse 187AW2F
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7140
G.E. K-2468B	Philco 352-7150
G.E. K-2469A	Philco 352-7071
G.E. K-2744B	Philco 352-7178
AN/APN-9 (901756-501)	Raytheon UX-7350
AN/APN-9 (901756-502)	Raytheon UX-10066
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse 132-AW	W.E. D-163325
Westinghouse 139DW2F	W.E. D-164661
Westinghouse 166AW2F	W.E. KS-9563
Westinghouse 176AW2F	

SPARE PARTS
FOR ARMY AND NAVY RADIO, RADAR & SONAR EQUIPMENT

AN/APS-2	AN/APN-4	AN/ARC-5	QCB
AN/APS-3	AN/APN-9	SF	QCJ
AN/APS-4	AN/ARC-1	SL	QCL
AN/APS-15	AN/ARC-3	SO	WEA
etc.	etc.	etc.	etc.

QUOTATIONS UPON REQUEST

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 Microsec. 200 PPS 67 ohms imbed, 3 sections $4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 Microsec. 200 PPS, 67 ohms imped, 3 sections $6.75
7.5 E4-16-60-67P, 7.5 KV, "E" Circuit 4 sections, 16 microsec. 60 PPS, 67 ohms imped $8.25
10-E4-.85-750-50P, 10 KV, "E" circuit, .85 microsec. 750 PPS. 50 ohms imped., 4 sections. $26.25
10-E4-2.2-375-50P, 10 KV, "E" circuit, 2.2 microsec. 375 PPS. 50 ohms imped., 4 sections. $26.25
15 E4-.91-400-50P, 15 KV, "E" Circuit .91 microsec. 400 PPS. 50 ohms imped, 4 sections $37.50
15-A-1-400-50P, 15 KV, "A" Circuit, 1 microsec. 400 PPS, 50 ohms imped $32.90

LECTRONIC RESEARCH LABORATORIES
715-19 ARCH ST. PHILA 6, PA.
Telephones - MARKET 7-6771-2-3
CABLE ADDRESS - "LECTRONIC PHILADELPHIA"

TUBE SPECIALS

GUARANTEED BRAND NEW

STANDARD BRANDS ONLY

Receiving Tubes

OOA	$1.50
O1A	.67
OZ4	.74
OZ4A	.90
1A3	.71
1A5GT	.72
1A6	.72
1A7GT	.91
1AB5	.89
1B3GT	.99
1B4P	1.17
1C5GT	.85
1C6	.69
1C7G	.69
1D8GP	.69
1D7G	.69
1D8GT	.71
1E5GP	.71
1F4	.69
1F5G	.69
1F6	.71
1G4GT	.69
1G5G	.69
1G6GT	.69
1H4G	.89
1H5GT	.74
1H6G	.99
1H6GT	1.01
1J5G	.74
1J6G	.95
1L4	.69
1LA4	.87
1LA6	1.10
1LB4	1.01
1LC5	.81
1LC6	.93
1LD5	.93
1LE3	.93
1LH4	.82
1LN5	.91
1N5GT	.85
1N6G	.97
1P5GT	.69
1Q5GT	.99
1R4	.69
1R5	.89
1S4	.71
1S5	.81
1T4	.81
1T5GT	.71
1U4	.86
1U5	.81
1V	.69
1X2	1.09
2A3	1.28
2A5	.79
2A7	.89
2B7	.79
2E5	.94
2X2	.89
2X2A	1.85
3A4	.65
3A5	1.89
3A8GT	2.25
3B7	.87
3C6	1.15
3D6	.57
3LF4	.91
3Q4	.77
3Q5GT	.83
3S4	.77
3V4	.87
5AZ4	.69
5R4GY	1.59
5T4	1.91
5U4G	.69
5V4G	1.07
5W4	.82
5X4G	.87
5Y3GT	.59
5Y4G	.71
5Z3	.87
5Z4	1.11
6A4	1.35
6A6	1.17
6A7	1.05
6A8	1.08
6AB4	.99
6AB7	1.05
6AC5GT	1.19
6AC7	1.11
6AC7W	3.25
6AD4G	.98
6AD7G	1.31
6AE6G	.89
6AF6G	.89
6AG5	.87
6AG7	1.59
6AH6	1.39
6AJ5	2.50
6AK5	1.10
WE-6AK5	2.85
6AK5W	3.05
6AK6	.99
6AL5	.69
6AL5W	2.98
6AQ5	.89
6AQ6	.79
6AR5	.79
6AS5	.99
6AS6	3.38
6AS7G	4.53
6AT6	.63
6AU5GT	1.21
6AU6	.69
6AV6	.63
6B4G	1.60
6B5	1.20
6B7	.97
6B8	.99
6B8G	.85
6BA6	.72
6BA7	1.20
6BC5	.85
6BC7	1.10
6BD5GT	1.60
6BD6	.99
6BE6	.72
6BF5	1.10
6BF6	.83
6BG6G	1.92
6BH6	.99
6BJ6	.99
6BK7	1.60
6BL7GT	1.45
6BN6	1.59
6BQ6GT	1.26
6C4	.65
6C5	.75
6CB6	.89
6C6	.88
6C8G	.96
6CD6G	2.40
6D6	.88
6D8G	.83
6E5	1.10
6F5GT	.83
6F6	.99
6F6G	.99
6F7	.85
6F8G	.91
6G6G	1.06
6H6	.53
6H6GT	.83
6J5	.75
6J5G	.64
6J5GT	.64
6J6	1.09
6J7	.99
6J7GT	.79
6J8G	1.28
6K5GT	.99
6K6GT	.69
6K7	.83
6K7G	.88
6K8	1.22
6L5G	1.06
6L6	1.87
6L6G	1.79
6L6GA	1.59
6L7	1.08
6L7G	.95
6N7	1.19
6N7GT	1.10
6P5GT	.96
6Q7	.89
6Q7G	.89
6R7	.99
6S4	.72
6S7	1.06
6S7G	.99
6SA7	.84
6SA7GT	.74
6SB7Y	1.05
6SC7	1.20
6SC7GT	1.05
6SD7GT	.94
6SF5	.83
6SF5GT	.80
6SF7	.69
6SG7	.91
6SH7	.89
6SH7GT	.89
6SJ7	.89
6SJ7GT	.89
6SK7	.89
6SK7GT	.89
6SL7GT	.96
6SN7GT	.89
6SN7WGT	2.30
6SQ7	.75
6SQ7GT	.75
6SR7	.81
6SS7	.99
6ST7	1.25
6T7G	1.09
6T8	1.11
6U5	1.19
6U7G	.88
6V6	1.60
6V6G	.89
6V6GT	.79
6W4GT	.72
6W6GT	.99
6X4	.59
6X5GT	.59
6Y6G	.99
6ZY5G	.89
7A4	.79
7A5	.88
7A6	.83
7A7	.83
7A8	.83
7AD7	1.44
7AH7	1.08
7B4	.83
7B5	.81
7B6	.83
7B7	.83
7B8	.89
7C4	.69
7C5	.83
7C7	.83
7E5	1.20
7E6	.88
7E7	.83
7F7	.99
7F8	1.59
7G7	1.32
7H7	.83
7J7	1.32
7K7	1.32
7L7	.97
7N7	.97
7Q7	.83
7R7	.94
7S7	1.11
7V7	1.11
7W7	1.11
7Y4	.73
7Z4	.89
10	.45
12A	.65
12A6	.71
12A6GT	.69
12A7	1.16
12A8GT	.77
12AH7GT	1.32
12AL5	.89
12AT6	.59
12AT7	1.15
12AU6	.79
12AU7	.95
12AV6	.63
12AW6	1.20
12AX7	1.08
12BA6	.72
12BA7	.95
12BD6	.99
12BE6	.70
12C8	.77
12F5GT	.79
12H6	.69
12J5GT	.69
12K8	.83
12Q7GT	.67
12SA7	.89
12SA7GT	.89
12SF5	.79
12SF5GT	.79
12SF7	.79
12SG7	.99
12SH7	.73
12SJ7	.79
12SJ7GT	.89
12SK7	.81
12SL7GT	1.03
12SN7GT	.99
12SQ7GT	.79
12SR7	.89
12SR7GT	.89
12X3	1.19
12Z3	.89
14A4	.97
14A7	.97
14B6	.93
14B8	1.09
14C5	1.29
14C7	1.15
14E6	1.09
14E7	1.29
14F7	.93
14H7	.93
14J7	.93
14N7	.93
14R7	.93
14W7	.93
14X7	.93
19	.89
19T8	1.16
22	1.16
24A	.79
25A6	1.16
25L6GT	.89
25Z5	.99
26	.79
27	.69
28D7	1.75
30	.72
30 Spec.	.48
31	.62
32	.99
32L7GT	.87
33	.99
34	.99
35/51	.79
35A5	.89
35B5	.87
35L6GT	.81
35W4	.55
35Y4	.81
35Z4GT	.69
35Z5GT	.69
36	.69
37	.69
38	.69
39/44	.89
41	.71
42	.89
43	.89
45	.89
45Z5GT	.79
46	.81
47	.98
50	.88
50L6GT	.79
50Y6GT	.92
53	.95
55	.99
BK55B	.40
CK55B	.52
FG-17/5557	5.25
FG-33	17.50
FG-41	122.50
FG-67	14.50
FG-81A	4.95
71A	.79
75	.89
76	.69
77	.69
78	.79
80	.65
81	1.41
82	1.19
83	1.11
83V	1.45
84/6Z4	.79
85	.79
89Y	.55
117L7GT	1.89
117P7GT	1.89
117Z3	.74
117Z6GT	.97
FM-1000	1.59

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3AP4	10.25
3BP1	7.95
3CP1	2.25
3DP1	4.85
3DP1A	6.75
3EP1	4.95
3FP7	4.95
3FP7A	6.95
3GP1	4.95
3HP7	4.95
4AP10	4.75
5AP1	5.95
5AP4	4.75
5BP1	5.75
5BP4	5.75
5CP1	4.95
5CP7	9.50
5FP7	4.95
5HP1	5.75
5HP4	5.75
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	19.75
5LP5	19.75
5MP1	10.65
7BP1	8.75
7BP7	7.95
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	12.85
9LP7	9.95
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10FP4	24.50
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12GP7	16.50
12HP7	16.50
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905	4.45

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1P26	1.27
918	1.65
919	1.95
923	1.35
927	1.85
931A	6.95
1645	1.95

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2C33	4.95
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3C23	9.95
3C31/EL-C1B	3.95
3C45	17.50
4C35	27.00
EL-C5B	9.95
5C22	53.45
C6A	6.75
C6J	9.95
FG-17/5557	5.25
FG-33	17.50
FG-41	122.50
FG-67	14.50
FG-81A	4.95
71A	7.85
FG-95/5560	26.25
FG-104/5561	26.60
FG-105	19.50
FG-166	95.00
FG-172	39.50
FG-178	14.50
RX-233A	4.95
FG-235A/5552	94.50
FG-271/5551	62.50
393A	8.60
394A	4.77
GL-415/5550	39.50
KU-610	12.50
KU-623	39.50
KU-628	22.25
KU-634	39.50
WL-652/5551	62.50
WL-654/659	82.00
WL-672	22.00
WL-677	39.50
WL-681/5550	39.50
722A	3.75
884	1.85
885	1.90
1645	1.80
1904	14.80
2050	1.80
2051	1.15

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OA3	1.51
OB2	1.10
OB3	1.29
OC3	1.20
OD3	1.15
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1B22	3.25
1B23	9.95
1B24 (West)	12.95
1B24(Sylv)	18.95
1B24AA	39.50
1B26	3.73
1B27	19.50
1B29	2.90
1B32	3.95
1B35	11.00
1B36	12.50
1B38	32.50
1B40	4.95
1B41	47.50
1B42	9.80
1B54	32.50
1H20	.85
1S21	9.50
1Z2	3.75
2B22	2.20
2C21	.75
2C22	.75
2C26	.49
2C26A	.49
2C34	.49
2C39	22.00
2C40	16.25
2C42	26.50
2C43	19.25
2C44	1.50
2C46	29.50
2C51	5.75
2E22	1.85
2E24	4.10
2J21A	9.95
2J22	9.95
2J26	26.50
2J27	24.50
2J31	39.50
2J32	42.50
2J33	39.50
2J34	39.50
2J36	85.00
2J37	13.70
2J38	17.50
2J39	49.50
2J40	39.50
2J48	49.50
2J49	65.00
2J50	39.50
2JB51	2.50
2J54	67.50
2J55	87.50
2J56	150.00
2J61	45.20
2J62	165.00
2K23	37.50
2K25	33.50
2K26	107.15
2K28	34.50
2K29	26.00
2K33	295.00
2K45	145.00
2K54	135.00
2K55	135.00
2X2A	1.85
3B22/EL-1C	2.95
3B23	4.75
3B24	5.25
3B24W	7.95
3B25	4.50
3B26	3.75
3B27	4.20
3B28	7.75
3C24	1.85
3C27	6.95
3C37	32.50
3D21	1.98
3D21A	4.75
3E29	14.50
3J31	115.00
4-125A	29.50
4A1	1.18
4B22/EL-5B	8.95
4B24	5.75
4B25/EL-6CF	8.95
4E27	17.25
4J36	150.00
4J35	120.00
4J50	375.00
4J52	490.00
5D21	26.50
5J29	18.50
6-8D	.85
6AN5	5.95
6AR6	3.35
6C21	29.50
6C24	52.50
6P4	5.95
6J4	7.95
7-7-11	1.10
10T1	.88
10Y	.45
13-4	.80
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REL-21	2.25
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53A	5.60
RK-59	2.44
VT-62(Br)	1.15
RK 63	22.50
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	3.50
VR-75/OA3	1.51
75T	5.80
VR-78	.64
VR-90/OB3	1.29
VT-98 (Br)	65.00
C100E	2.30
100R	2.98
100TH	10.25
WE-101F	3.62
WE-102F	2.85
VR-105/OC3	1.20
WE-113A	1.32
HY-114	.75
WE-117A	.95
F-123A	8.95
WE-124A	3.50
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150/OD3	1.15
FG-190	12.15
HF-200	16.50
203A	7.40
203B	6.33
204A	49.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
221A	1.95
227A/AT	4.60
WE-231D	2.25
232CH	240.00
WE-244A	5.20
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
250TH	22.50
250TL	22.50
WE-252A	5.65
WE-254A	5.90
WE-257A	3.77
WE-274A	5.80
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-288A	5.57
WE-288A	7.90
WE-294A	5.75
304TH	9.75
304TL	9.75
307A	5.50
WE-309A	6.45
WE-310A	7.50
WE-313C	4.15
316A	.89
327A	4.25
WE 331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
361A	4.75
368A	6.90
371A	.95
371B	.95
388A	2.95
WE-399A	4.70
417A	16.95
434A	17.50
446	1.95
446A	1.95
446B	2.25
450TH	42.50
450TL	42.50
451	1.39
471A/1B21A	2.75
503AX	1.45
506AX	1.47
507AX	1.47
527	17.50
530	17.20
531	8.25
532A	3.95
WL-533	65.00
559	2.20
561	3.50
HY615	.49
WL670A	8.70
700A	24.50
700B	24.50
700C	24.50
700D	24.50
701A	6.95
702A	2.95
702B	4.25
703A	6.95
704A	.95
705A	2.75
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	9.95
707B	22.50
708A	4.85
709A	4.87
710A	1.78
713A	1.45
714AY	10.75
715A	6.75
715B	12.75
715C	26.50
717A	1.47
718AY	45.00
718BY	45.00
720DY	75.00
721A	4.90
723A	9.95
723A/B	18.50
724A	3.23
724B	3.22
725A	8.95
726A	14.50
726B	45.00
726C	65.00
730A	25.00
731A	2.45
WL-787	9.80
785Y	1.40
800	1.88
801A	.48
803	4.95
805	4.50
806	24.50
807	1.70
808	2.65
809	2.40
810	10.95
811	3.60
813	10.50
814	3.50
815	2.95
816	1.45
826	1.45
828	13.48
829	9.95
829A	14.50
829B	14.50
830B	3.95
832	7.95
832A	9.95
833A	45.00
836	4.10
837	1.85
838	3.25
841	.49
843	.59
845	5.75
845W	6.75
849	29.50
851	67.00
852	22.60
860	4.95
861	24.50
864	.39
865	1.28
866A	1.48
869B	45.00
872A	3.95
874	1.45
876	1.60
878	1.85
886	3.50
954	.39
955	.79
956	.49
957	.49
958A	.69
959	1.50
991	.45
1003	.90
CK-1005	.79
CK1006	3.75
E-1148	.35
1201	1.20
1203	.69
1291	.69
1294	.69
1299	.69
1602	2.25
1613	1.20
1614	2.00
1616	1.87
1619	.39
1622	2.30
1624	1.95
1625	.45
1626	.39
1629	.39
1630	.95
1631	1.35
1632	.75
1636	3.10
1638	.70
1642	.75
1644	1.17
1655	1.90
1960	.79
5611	135.00
5651	3.95
5654	2.90
UX-6053	.65
7193	.75
8005	5.95
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.95
8020	1.39
8025	6.95
8901	1.75
9002	1.50
9003	1.75
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9005	1.95
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1G	5N	A	2J1M1	C-69405-2	C-78411
1HG	5SF	B	2J5A2	C-69-106	C-78414
1SF	5SG	M	2J5D1	C-69406-1	C-78415
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(Approx. size overall) . . . 3¾" x 1¼" diameter)
Delco-Type 5069230: 27.5 volts; DC; 145RPM ..... **$19.95 ea.**

PM Motor, Delco Type #5069370: 27.5 volt; DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ⅛", diameter 0.125" **$12.50**
PM Motor, Diehl Mfg. SS FD6-21; 27.5 volt; DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ⅛", diameter 0.125" **$12.50**

AC CONTROL MOTOR

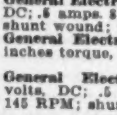
Diehl Mfg. Co., FPE-25-7, 26 Volts, 2 ph 1600 RPM, .85 amps **$15.00**
Diehl Mfg. Co., FPE-25-11: 75 to 115 volts; 11 amps. 60 cycle, 2 phase 2 pole. Low inertia motor, 5 watts output **$30.00**
A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 60; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝" ..... **$15.00 ea.**

400 CYCLE MOTORS

PIONEER: TYPE CK5 2 Phase; 400 cycles **$35.00 ea.**
EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle ..... **$17.50 ea.**
AIRESEARCH: 115V; 40 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03 ..... **$10.00 ea.**
EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM ..... **$12.50 ea.**
EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle. Single Phase **$12.50 ea.**
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps ..... **$79.50 ea.**
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, .12 H.P., 6500 RPM; 1.5 amps **$25.00**
Electric Motor: PNT—1400—A1—IA Serial No. 207, 208 V., 400 cycles, 3 phase Kearfott Co., Inc. ..... **$17.50 ea.**
SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle; with 40-1 Reduction Gear $17.50 ea.

SMALL DC MOTORS

DELCO #5068750: constant speed; 27 VDC; 160 RPM; built-in reduction gears and governor ..... **$17.50 ea.**
J. OSTER: series, reversible motor; 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps; **SPERRY #806069;** approx. size 1⅝ " x 3½" **$7.50 ea.**
(Approx. size....4" long x 1¼" dia.)
General Electric Type 5AB16AJ37; 27 volts. DC; .5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible. **$15.00 ea.**
General Electric, Mod. 5BA10FJ33; 12 oz. inches torque, 12 V DC, 56 RPM, 1.02 amp. **$15.00 ea.**
General Electric Type 5BA10AJ52C; 27 volts, DC; .5 amps, 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$15.00 ea.**
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64, 160 r.p.m.; 65 amp; 12 oz.-in. torque; 27V DC ..... **$19.95 ea.**



WESTINGHOUSE OVER-CURRENT RELAY: Type MN, adjustable from .04-.16 amp. (1210991). External reset push button. Enclosed in glass case . . . hand calibrated. NEW LOW PRICE. **$14.95**

BLOWER

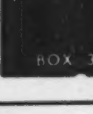
Eastern Air Devices, Type J31B; 115 volt; 400-1200 cycle; single phase; variable frequency; continuous duty; L & R #2 blower; approx. 22 cu. ft./min. **$15.00**

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FIA, 17CFM, complete with capacitor. New ..... **$12.50 ea.**

MICROPOSITIONER

Barber Colman AYLZ 2133-I Polarized D.C. Relay: Double Coil Differential sensitive, Alnico P. M. Polarized field. 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc. ..... **$12.50 ea.**



SENSITIVE ALTIMETERS

Pioneer Sensitive altimeters, 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required . . . **$12.95 ea.**

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp. ..... **$80.00 ea.**

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 80; 380/500 cycle 1500 VA. **Input:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5. **BRAND NEW** ..... **$39.95 ea.**

MG 153 HOLTZER-CABOT

Input: 24 V. DC, 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated ..... **$95.00 ea.**

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps, 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 15-12 amps. Voltage and frequency regulated ..... **$89.50 ea.**

12116-2-A PIONEER

Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC 5 amp.... **$90.00 ea.**

10285 LELAND ELECTRIC

Output: 115 Volts AC, 750 V.A., 3 phase, 400 cycle, .90 PF, and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps. cont. duty, 6000 RPM. Voltage and Frequency regulated... **$195.00**

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont. Duty ..... **$90.00 ea.**

SOLA TRANSFORMERS

One KVC, 210-270 Volts, 240 Sec., 3-Phase
#30663 ..... $175.00

FILAMENT, Gen. Elec. #7466321: Primary 110/125 Volts. Secondary 11 Volts, 65 Amps, 975 KVA. Shipping wt. approx. 60 pounds. **$24.95**
FILAMENT, AMERTRAN #29048: Primary 115 Volts, 50/60 cycle. Secondary 5 volts, 190 amp. Shipping weight approx. 75 lbs. **$36.50**
VARIABLE, AMERTRAN #29144: 250 VA, 103-126 commutator range, fixed windings, 115 volts, max. 2.17 amps **$19.95**

METERS

AMMETER: DC; 2" 100-100, complete with external shunt ..... **$5.95 ea.**
AC Volt, Westinghouse, Type NA-35—3-inch round. F.S.-10 MA ..... **$6.95 ea.**
AMP METERS; DC., 0-300 amps, 3" round type complete with external shunt. **$6.95 ea.**
ELAPSED TIME METER, Aero Instrument Co.—Model 1001. Records operating time of AC electrical and electronic equipment. Registers up to 9,999.9 hours in 1/10th hour increment . . . then automatically resets. Diameter 3⅛" with glass covered face, 120 VAC; 60 cycle. NEW.. **$14.95**

SCHWEIN REMOTE CONTROL DUAL GYRO

Free and rate gyro type 45600. Contains two 28 volt DC constant speed gyros . . . one operates horizontally, the other vertically. Vertical master gyro influences horizontal gyro position, which in turn will actuate a series of limiting switches controlling any number of electrical devices. Both gyros turn in excess of the 30,000 rpm. Size 8" x 4¼" x 4¼". Comen with metal cover ..... **$22.50 ea.**

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

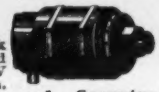
PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

TACHOMETER INDICATOR

SINGLE
Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer **$9.95 ea.**

TACHOMETER GENERATOR



Pioneer Instrument Mark V, screw mount. Used with Kollsman Mark V Indicator ..... **$25.50 ea.**
Tachometer Indicator and Generator (above) ..... **Both $33.50**

G. E. GENERATORS

General Electric Type 5ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia. **$99.50 ea.**

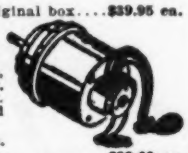
SINE-COSINE GENERATORS

(Resolvers)
Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle ..... **$30.00 ea.**
Diehl Type FPE-43-1 same as **FJE-43-9** except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor ..... **$25.00 ea.**
Arma Resolver Type 213014; equal in size to size 5 synchro; 55-60 cycle; single phase primary, 2 phase secondary **$79.50**

GENERATORS

Eclipse-Pioneer; 716-3A (Navy Model NEA-3A) OUTPUT: 115 VAC; 10.4 amps; 800 cycle; single phase; 28.6 VDC; 60 amps @ 2400 rpm; spline drive; self exciting; wt. 60±.
BRAND NEW in original box.... **$39.95 ea.**

SYNCHRONOUS SELSYNS



110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.
Quantities Available.
REPEATERS ..... **$20.00 ea.**
TRANSMITTERS ..... **$20.00 ea.**

SYNCHROS

1F Special Repeater (115V-400 Cycle) **$15.00 ea.**
2JIF 3 Generator (115-400 cyc.)... **$10.00 ea.**
5CT Control Transformer; 90-50 Volt; 60 Cyc. ..... **$50.00 ea.**
5F Motor (115/90 volt—60 cyc.).. **$60.00 ea.**
5G Generator (115/90 volt—60 cyc.) **$50.00 ea.**
5/DG Differential Generator (90/90 volts —400 cyc.) ..... **$30.00 ea.**
TRANSMITTER, BENDIX C-78248; 115 Volt, 60 Cycle ..... **$25.00 ea.**
Differential—C-78249; 115 Volt; 60 Cycle **$5.00**
REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle ..... **$37.50 ea.**
REPEATER, AC synchronous 115 V., 60 cycle, C-78863 ..... **$15.00 ea.**
7G Synchro Generator (115/90 volt; 60 cycle) **$75.00**
6G Synchro Generator (115/90 volt; 60 cycle) **$60.00**
6DG Synchro Differential Generator (90/90 volt; 60 cycle) **$60.00**
2JF51 Selsyn Control Transformer: 105-55 Volts; 60 Cycle **$50.00**
2JD5J2 Selsyn Motor: 115-90 Volts; 60 cycle **$50.00**
5JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle **$50.00**
2JIF1 GENERATOR: 115—57.5 Volt; 400 cycle ..... **$12.50 ea.**
2J1H1 DIFFERENTIAL GENERATOR: 57.5—57.5 Volt; 400 cycle ..... **$12.50 ea.**
2J1G1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle ..... **$7.50 ea.**

PIONEER AUTOSYNS

AY-1 ..... 26 Volt—400 Cycle **$6.95**
AY-5 ..... 26 Volt—400 Cycle **$7.95**
AY21D **$25.50**
AY6—26 Volt—400 cyc. ..... **$4.95 ea.**
AY30D—26 Volt—400 cyc. ..... **$25.00 ea.**
AY14D **$14.00**
AY34 ..... **$20.00**
AY20—26 Volt—400 cyc. ..... **$12.50 ea.**

PIONEER TORQUE UNITS

TYPE 12604-3-A: Contain CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn. follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1. **$70.00 ea.**
TYPE 12602-1-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn. ..... **$70.00 ea.**
TYPE 12602-1-A: Same as 12606-1A except it has base mounting type cover for motor and gear train. ..... **$70.00 ea.**

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JAN TUBES

OB3/VR90	$ .85	832A	$ 8.50
OC3/VR105	.85	836	3.00
3E29	12.95	GL8002R	95.00
6C21	12.95	9003	1.00
204A	75.00	3BP1	5.95
368AS	7.00	5FP4	3.95
371B	.75	12GP7	14.95

FILAMENT TRANSFORMERS

AMERTRAN 5 VOLT C.T.—10 AMP SEC. 230 VOLT 50/60 CYCLE PRIMARY 25,000 VOLT TEST

Stock No. 6212A — Price Each **$10.00**

CHICAGO TRANSFORMER—10 VOLT C.T.—6.5 AMP. SEC. 230 VOLT 50/60 CYCLE PRI. 8000 VOLT TEST

Stock No. 6213A — Price Each **$5.00**

TEST SETS

IE-38 FOR SCR 522 .....$35.00
EE-86G TELEPHONE TEST SET.....$25.00

POWER TRANSFORMER

PRI: 115 VOLT 60 CYCLE
SEC: 488V. C. T. @ 95MA 6.3 VOLT @ 6.2 Amps.
HERMETICALLY SEALED. P/O R-19/TRC-1

Stock No. 6114A — Price Each **$2.00**

SENSITIVE RELAY SPST—2MA—6500 Ohms. Stock No. 162152A. Price Each $1.25.

RADAR OSCILLATOR APR-5

Sig. Cr. Stk. No. 2C 2784. Used for tuning 1000-3100 Mg.

POWER TRANSFORMER

Horizontal Double Half Shell Type. Pri.: 117 Volt—60 Cycle. Sec.: 265-0-265 V.A.C. @ 40 Ma. Sec.: 6.3 V.A.C. @ 1.65 Amps. Mtg. Centers 2½" x 2". H.V. Center Tap is grounded to core.

Stock No. 6183 — Price Each **$1.25**

HIGH FIDELITY TRANSFIRMER

P. P. 10,000 ohm to 250 ohm Line. Frequency Response 30 to 20,000 C.P.S. plus or minus 1 DB. Grey Rectangular Case 3" x 2½" x 3½" high. Bottom Solder Lug Terminals. 4 Stud Mtg. Bolts.

Stock No. 5792A — Price Each **$3.50**

HIGH CURRENT FILAMENT TRANSFORMER

Primary 115 VAC 60 Cycle. Secondary 1.25 VAC at 100 Amp.

Stock No. 5783A — Price Each **$5.00**

.01 MFD.—600 VOLT MICA CONDENSERS

Large quantities available in both CM-35 and CM-40 case sizes.

TOLERANCE	PRICE PER 1000
5%	$150.00
10%	125.00
20%	100.00

AN/APQ-13 MODULATOR UNIT

Signal Corps # 2CK2537-13 W.E. NNO. D-151784. Oil filled modulator containing a pulse amplifier and associated rectifier. **$125.00 ea.**

SYNCHRO CAPACITOR

3 x .6 MFD. 90V 60 Cycle. 3 Bakelite insulated terminals. 2½" x 1¾" x 3½" high can.

Stock No. 6188A — Price Each **$1.50**

4 WATT RHEOSTAT

Type M200R 4 Watt 200 Ohm Wire Wound Rheostat. ⅜" bushing. ⅝" long. ¼" diam. shaft. $25.00 per 100

Stock No. 6137A — Price Each **30¢**

J-38 KEYS

Signal Corps Type J-38 Keys

Stock No. 5293A — Price Each **85¢**

HIGH VOLTAGE TRANSFORMER

21,000 volt 100MA. Half Wave oil filled. Maloney Electric Co.

Stock No. 5728A — Price Each **$300.00**

MICA CAPACITORS

Sizes from 10 to 7,000 MMFD in CM20, CM 30, CM35 and CM40 case sizes. Tan mica and silver mica.

Complete lists with prices available upon request.

G. E. SATURABLE REACTOR

15 KVA. #67G469 **$100.00**

72 OHM COAX

Plastoid RG-59/U Coax.

Stock No.		Price
5324A	1000 Ft. Spools	$60.00
5325A	100 Ft. Coils	7.00

83-1R COAX CONNECTOR

Stock No. 5657A — Price Each **50¢**

THORDARSON AUDIO PASS FILTERS

Band pass 800 to 1200 cycles Input 10000 ohms—Output 25000 Ohms Level 10DB

Stock No. T48500 Price to: $5.50 ea.

ONAN GAS-DRIVEN GENERATOR
14 V-2500 WATT D.C. $225.00

GAS DRIVEN LIGHT PLANT
125V 3 Phase 3KVA 50-60 Cycle
$395.00

SWITCHBOARD BD74

RCA and KENRAD
Individually Boxed
JAN 826's

75¢ Each 100 Lots — 85¢ ea

RAYTHEON
Individually Boxed
JAN VT-127's

25¢ Each 100 Lots — 35¢ each 3 for $1.00

10 MFD.—600 VDC

Sprague No. R2-157. 10 Mfd. 220 VAC 600 VDC Capacitator with Universal Mounting Ring. 2-7/16" Diameter. 3⅝" high. Bakelite insulated terminals.

Stock No. 5958A — Price Each **95¢**

TRANSMITTING MICAS

Stock No.	Cap.	Test Volts	Type No.	Price Each
5493A*	.01	1000	144S	.35¢
5494A	.02	1000	144T	.40¢
5495A	.006	1200	A2	.40¢
5496A	.0001	1500	BE 1S	.30¢
5498A	.004	2500	4	.35¢
5499A	.001	5000	F	.40¢
5500A	.0036	5000	A2	$1.00
5501A	.15	1000V	XS	1.50
5502A	.00007	2500V	3	.90¢
5503A	.00005	3000V	15L	1.00
5504A	.0001	5000V	F2L	1.00
5505A	.0005	5000V	F2I	1.00
5506A	.000025	10,000	PL-34L	5.95
5507A**	.00015	10,000	PL-315	7.95

*Supplied with Motor Bracket
**D.C. Working Voltage
OTHER TYPES AND SIZES AVAILABLE

BUTTERFLY CONDENSERS

FIG. 1

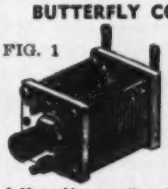


FIG. 2

9-62 mmfd per section. 6-34 mmfd sections in series. Double ceramic end plates and bearings. ¼" diam. shaft. 5/16" long. 065 Plate spacing end plates 1-⅝" square.

Stock No. 5076-A — Fig. 1 — Price Each **90¢**

4-22 mmfd per section. 3-12 mmfd sections in series. Single ceramic end plate 1-⅝" square, ¼" diam. x ¼" long shaft.

Stock No. 5077-A — FIG. 2 — Price Each **60¢**

AN-109A WHIP ANTENNA

$1.25 w/base, .75 less base.

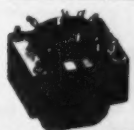
6.3 VOLT FILAMENT TRANSFORMERS

Primary 115 Volt 60 Cycle 1600 Insulation Th... 6.4 Volt Secondaries

6.3 Volts @ 4.0 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅛" Core Size. ½" above Chassis. Soder Lug Terminals—All Terminals Marked.

Stock No. 5254A



Price Each **$2.65**

TERMS:

Open Account to rated or Acceptable reference accounts. Others Pre-payment of 25% deposit with order, balance C.O.D. Price F.O.B. Chicago and subject to change without notice. Merchandise subject to prior sale.

ORDER TODAY!

Radio Surplus Corp.

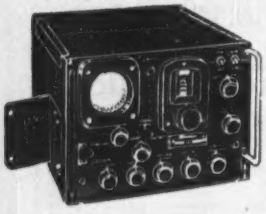
732 South Sherman Street
Chicago 5, Illinois
Phone: HArrison 7-5923

NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA2	$1.40	2J21A	17.95	4E27	17.50	BK-73	1.95	450TH	45.00	806	27.50	955	.55
OA3	1.10	2J22	17.95	4J25	199.00	100TH	9.95	450TL	45.00	807	1.69	956	.69
OB2	1.35	2J26	27.75	4J26	199.00	FG95	24.95	464A	9.95	808	3.50	957	.29
OC3	1.25	2J27	29.95	4J27	199.00	FG105	19.00	471A	2.75	810	11.00	958A	.69
OD3	1.25	2J31	29.95	4J31	199.00	203A	8.95	527	15.00	811A	3.95	991	.65
C1B	3.95	2J32	69.95	4J32	199.00	211	.95	WL530	3.50	813	9.95	F1148	.35
1B21A	2.75	2J36	105.00	4J33	199.00	217C	18.00	WL531	22.50	814	3.95	1280	1.25
1B22	3.95	2J38	17.25	4J37	199.00	242C	10.00	WL533	17.50	815	1.50	1611	1.95
1B23	9.95	2J39	12.50	4J38	89.00	244A	12.95	700A/D	25.00	816	1.45	1613	1.38
1B24	17.95	2J40	35.00	4J39	199.00	249C	4.95	701A	7.50	829	12.95	1616	2.95
1B26	2.95	2J42	250.00	4J41	199.00	250TH	22.50	703A	6.95	829A	13.95	1619	.89
1B27	13.50	2J49	169.00	CSB	3.25	250TL	19.95	705A	3.95	829B	15.95	1622	2.75
1B32	4.10	2J50	195.00	5BP1	6.95	274A	3.00	707A	17.95	830B	2.50	1624	2.00
1B34	33.00	2J61	45.00	5BP4	6.95	274B	3.00	707B		832	7.95	1625	.45
1B42	19.95	2J62	45.00	5CP1	6.95	304TH	10.00	714AY	17.95	832A	9.95	1851	1.85
1B51	9.95	2K25	29.50	5D21	21.00	304TL	10.00	715A	7.95	833A	49.95	2050	1.85
1B56	49.95	2K28	37.50	5JP1	27.50	307A	4.95	715B	12.00	834	7.95	2051	1.80
1B60	69.95	2K29	37.50	5JP2	19.50	310A	5.95	715C	25.00	836	4.95	8012	4.25
1N21	1.35	2K41	150.00	5JP4	27.50	311A	6.95	717A	1.95	837	2.95	8013	2.95
1N21A	1.75	2K45	149.50	WE6AK5	2.50	312A	3.95	718AY/EY	48.50	838	6.95	8013A	5.95
1N21B	4.25	2V3G	2.10	C6A	12.50	323A	15.00	719A	29.50	845	5.50	8019	1.75
1N22	1.75	3BP1	7.50	C6J	18.95	327A	3.95	721A	3.95	849	52.50	8020	3.50
1N23	2.00	3B24	5.50	7BP7	7.95	328A	6.95	722A	3.95	851	80.50	8025	6.95
1N23A	2.75	3B24W	7.50	7DP4	10.00	350A	6.95	723A/B	24.95	860	4.95	PD8365	89.00
1N23B	4.25	3L3C	5.95	12AP4	55.00	350B	5.95	724A	4.95	861	29.50	9001	1.75
1N34A	.95	3C22	120.00	15E	1.95	357A	28.00	724B	6.95	866A	1.79	9002	.95
1N43	2.50	3C24	1.95	15R	.95	368AS	6.95	725A	9.95	869B	57.50	9003	1.75
2B22	1.95	3C31	7.95	NE16	.68	371B	2.95	726A	24.00	869BX	35.00	9004	1.75
2B26	3.75	3DP1A	10.95	FG17	6.95	385A	4.95	726B	56.00	872A	3.95	9005	1.90
2C34	.35	3DP1B2	12.00	KY21A	8.75	388A	2.95	726C	69.00	878	1.95	9006	.35
2C40	10.00	3E29	15.50	FG33	12.95	394A	7.95	728AY	27.00	884	1.95		
2C43	20.00	3GP1	5.50	35T	4.95	MX401U	.75	730A	24.00	885	1.75		
2C44	.90	4A21	2.75	45 Special	.35	417A	17.95	801A	1.00	889R	199.50		
2D21	1.75	4B26	6.95	RK39	2.95	434A	19.95	802	4.25	914	75.00		
2E22	2.75	4C27	25.00	HF50	1.75	446A	1.95	803	7.95	931A	5.00		
2E30	2.75	4C28	35.00	VT52	.25	446B	5.40	805	5.95	954	.35		

Minimum Order $25.00

MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER



Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

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370KC	402	433	462	490	516
372	403	434	463	491	518
374	404	435	464	492	519
375	405	436	465	493	520
376	406	437	466	494	522
377	407	438	468	495	523
379	408	440	469	496	525
380	409	441	470	497	526
381	411	442	472	498	527
383	412	443	473	501	529
384	413	444	474	502	530
385	414	445	475	503	531
386	415	446	476	504	533
387	416	447	477	505	534
388	418	448	479	506	536
390	419	450	480	507	537
391	420	451	481	508	538
392	422	452	483	509	540
393	423	453	484	511	
394	424	454	485	512	
395	425	455	486	513	
396	426	456	487	514	
397	427	457	488	515	
398	429	458			
400	430	459			
401	431	461			

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RF4A/AP Phantom Target S Band
TS10/APN Altimeter Test Set
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS15/AP Flux Meter
TS16/AP Altimeter Test Set
TS19/APQ 5 Calibrator
TS33/AP X Band Power and Frequency Meter
TS34/AP Western El Synchroscope
T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
TS100 Scope
TS102A/AP Range Calibrator
TS108 Power Load
TS110/AP S Band Echo Box
TS125/AP S Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS251 Range Calibrator APN9
TS270 S Band Echo Box
TS174/AP Signal Generator
TS175 Signal Generator
TS226 Power Meter
TS239A Synchroscope

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Insert	Shell 3102	3106A	3106B	3108A	3108B
8S-1P	$.85	$1.48			$1.96
8S-1S	.93	1.56			2.04
10S-2P	.78	1.44			2.07
10S-2S	.85	1.52			2.15
10SL-3P	1.07				
10SL-3S		1.81			2.44
10SL-4P	.93				
10SL-4S		1.67			2.30
12S-1P	1.00	1.70			2.48
12S-1S	1.19	1.89			2.67
12S-2P	1.00	1.70			2.48
12S-2S	1.19	1.89			2.67
12S-3P	1.00	1.70			2.48
12S-3S	1.19	1.89			2.67
12S-4P	.89	1.59			2.37
12S-4S	1.04	1.74			2.52
12-5P	.96	1.67			2.67
12-5S	1.11	1.81			2.78
12S-6P	2.52	3.22			4.00
12S-6S	1.67	2.37			3.15
14S-1P	1.22	2.00	2.19		2.89
14S-1S	1.33	2.11	2.30		3.00
14S-2P	1.37	2.15	2.33		3.04
14S-2S	1.48	2.26	2.44		3.15
14S-3P	1.30	2.07			3.26
14-3S	1.48	2.26			3.44
14S-4P	.93	1.70	1.89		2.59
14S-4S	1.04	1.81	2.00		2.70
14S-5P	1.52	2.30	2.48		3.19
14S-5S	1.63	2.41	2.59		3.30
14S-6P	1.67	2.44	2.63		3.33
14S-6S	1.77	2.56	2.74		3.44
14S-7P	1.22	2.00	2.19		2.89
14S-7S	1.33	2.11	2.30		3.00
14S-9P	1.07	1.85	2.04		2.74
14S-9S	1.19	1.96	2.15		2.85
14S-10P	1.37	2.15	2.33		3.04
14S-10S	1.48	2.26	2.44		3.15
14S-11P	1.37	2.15	2.33		3.04
14S-11S	1.48	2.26	2.44		3.15
14S-12P	1.22	2.00	2.19		2.89
14S-12S	1.33	2.11	2.30		3.00
14S-13P	1.22	2.00	2.19		2.89
14S-13S	1.33	2.11	2.30		3.00
14S-14P	1.37	2.15	2.33		3.04
14S-14S	1.48	2.26	2.44		3.15
14S-15P	1.77	2.63	2.81		3.63
14S-15S	1.89	2.74	3.07		3.89
16-2P	1.00	1.85			3.07
16-2S	1.22	2.07			3.30
16S-3P	1.04	1.89	2.07		2.89
16S-3S	1.15	2.00	2.19		3.00
16S-4P	1.19	2.04	2.22		3.04
16S-4S	1.30	2.15	2.33		3.15
16S-5P	1.19	2.04	2.22		3.04
16S-5S	1.44	2.30	2.45		3.30
16S-6P	1.33	2.19	2.37		3.19
16S-6S	1.44	2.30	2.48		3.30
16-7P	1.56	2.41			3.63
16-7S	1.77	2.63			3.85
16S-8P	1.63	2.48	2.67		3.48
16-8S	1.74	2.59	2.78		3.59
16-9P	1.48	2.33			3.56
16-9S	1.70	2.56			3.78
16-10P	1.37	2.22			3.44
16-10S	1.59	2.44			3.67
16-11P	1.19	2.04			3.26
16-11S	1.41	2.26			3.48
16-12P	1.41	2.26			3.48
16-12S	1.81	2.67			3.89
16-13P	1.85	2.70			3.93
16-13S	2.07	2.93			4.15
16S-14P	1.19	2.04	2.22		3.04
16S-14S	1.44	2.30	2.48		3.30
16S-15P	1.19	2.04	2.22		3.04
16S-15S	1.30	2.15	2.33		3.15
16S-16P	1.19	2.04	2.22		3.04
16S-16S	1.30	2.15	2.33		3.15
16S-17P	1.19	2.04	2.22		3.04
16S-17S	1.44	2.30	2.48		3.30
18-1P	2.41	3.37	3.59		4.63
18-1S	2.70	3.67	3.89		4.93
18S-3P	1.30	2.26	2.48		3.52
18-3S	1.63	2.59	2.81		3.85
18-4P	1.52	2.48	2.70		3.74
18-4S	1.85	2.81	3.04		4.07
18-5P	1.41	2.37	2.59		3.63
18-5S	1.77	2.74	2.96		4.00
18-6P	1.56	2.52	2.74		3.78
18-6S	1.89	2.85	3.07		4.11
18-7P	1.37	2.33	2.56		3.59
18-7S	1.70	2.67	2.89		3.93
18-8P	2.15	3.11	3.33		4.37
18-8S	2.48	3.44	3.67		4.70
18-9P	2.04	3.00	3.22		4.26
18-9S	2.37	3.33	3.56		4.59
18-10P	1.59	2.56	2.78		3.81
18-10S	2.00	2.96	3.19		4.22
18-11P	1.85	2.81	3.04		4.07
18-11S	2.19	3.15	3.37		4.41
18-12P	1.63	2.59	2.81		3.85
18-12S	2.15	3.11	3.33		4.37
18-13P	1.74	2.70	2.93		3.96
18-13S	2.30	3.26	3.48		4.52
18-14P	1.70	2.67	2.89		3.93
18-14S	2.04	3.00	3.22		4.26
18-15P	1.67	2.63	2.85		3.89
18-15S	2.00	2.96	3.19		4.22
18-16P	1.11	2.07	2.30		3.33
18-16S	1.44	2.41	2.63		3.67
18-17P	2.04	3.00	3.22		4.26
18-17S	2.37	3.33	3.56		4.59
18-18P	2.04	3.00	3.22		4.26
18-18S	2.37	3.33	3.56		4.59
18-19P	2.22	3.19	3.41		4.44
18-19S	2.74	3.70	3.93		4.96
18-20P	1.52	2.48	2.70		3.74
18-20S	2.00	2.96	3.19		4.22
18-21P	1.41	2.37	2.59		3.63
18-21S	1.81	2.78	3.00		4.04
18-22P	1.37	2.33	2.56		3.59
18-22S	1.70	2.67	2.89		3.93
18-23P	2.41	3.37	3.59		4.63
18-23S	2.70	3.67	3.89		4.93

Insert	Shell 3102	3106A	3106B	3108A	3108B
18-24P	$2.41	$3.37	$3.59	$4.63	$3.59
18-24S	2.70	3.67	3.89	4.93	3.89
18-25P	1.30	2.26	2.48	3.52	2.48
18-25S	1.63	2.59	2.81	3.85	2.81
18-26P	1.30	2.26	2.48	3.52	2.48
18-26S	1.63	2.59	2.81	3.85	2.81
18-27P	1.41	2.37	2.59	3.63	2.59
18-27S	1.77	2.74	2.96	4.00	2.96
18-28P	1.41	2.37	2.59	3.63	2.59
18-28S	1.77	2.74	2.96	4.00	2.96
18-29P	1.67	2.63	2.85	3.89	2.85
18-29S	2.00	2.96	3.19	4.22	3.19
18-30P	1.52	2.48	2.70	3.74	2.70
18-30S	2.00	2.96	3.19	4.22	3.19
18-31P	1.52	2.48	2.70	3.74	2.70
18-31S	2.00	2.96	3.19	4.22	3.19
20-1P	1.07	4.15	4.33	5.85	4.33
20-1S	3.44	4.52	4.70	6.22	4.70
20-2P	1.93	2.96	3.15	4.67	3.15
20-2S	1.33	3.56	3.78	5.30	3.78
20-3P	1.56	2.63	2.81	4.33	2.81
20-3S	1.96	3.04	3.22	4.74	3.22
20-4P	1.77	2.85	3.04	4.56	3.04
20-4S	2.15	3.22	3.41	4.93	3.41
20-5P	1.37	2.44	2.63	4.15	2.63
20-5S	1.74	2.78	2.96	4.48	2.96
20-6P	1.48	2.56	2.74	4.26	2.74
20-6S	1.85	2.93	3.11	4.63	3.11
20-7P	2.26	3.33	3.52	5.04	3.52
20-7S	2.59	3.67	3.85	5.37	3.85
20-8P	2.11	3.19	3.37	4.89	3.37
20-8S	2.89	3.96	4.15	5.67	4.15
20-9P	2.30	3.37	3.56	5.07	3.56
20-9S	2.63	3.70	3.89	5.41	3.89
20-11P	2.52	3.89	3.78	5.30	3.78
20-11S	3.22	4.37	4.56	6.07	4.56
20-12P	2.77	3.85	3.04	4.56	3.04
20-12S	2.22	4.30	4.48	6.00	4.48
20-13P	1.56	2.63	2.81	4.33	2.81
20-13S	2.81	3.89	4.07	5.59	4.07
20-14P	2.11	3.19	3.37	4.89	3.37
20-14S	2.89	3.96	4.15	5.67	4.15
20-15P	2.07	3.15	3.33	4.85	3.33
20-15S	2.74	3.81	4.00	5.52	4.00
20-16P	1.89	2.96	3.15	4.67	3.15
20-16S	2.52	3.59	3.78	5.30	3.78
20-17P	2.44	3.70	3.89	5.22	3.70
20-17S	3.85	4.93	5.11	6.96	5.11
20-19P	1.89	2.96	3.15	4.67	3.15
20-19S	2.78	3.85	4.04	5.56	4.04
20-20P	2.04	3.11	3.30	4.81	3.30
20-20S	2.70	3.78	3.96	5.48	3.96
20-21P	2.37	3.56	3.74	5.15	3.63
20-21S	2.81	3.89	4.07	5.59	4.07
20-22P	2.30	3.37	3.56	5.07	3.56
20-22S	3.22	4.30	4.48	6.00	4.48
20-23P	1.56	2.63	2.81	4.33	2.81
20-23S	2.33	3.41	3.59	5.11	3.59
20-24P	1.89	2.96	3.15	4.67	3.15
20-24S	2.63	3.70	3.89	5.41	3.89
20-25P	2.52	3.59	3.78	5.30	3.78
20-25S	3.30	4.37	4.56	6.07	4.56
20-26P	2.41	3.48	3.67	5.19	3.67
20-26S	4.93	6.00	6.19	7.70	6.19
20-27P	2.07	4.15	4.33	5.85	4.33
20-27S	3.44	4.52	4.70	6.22	4.70
20-28P	2.07	4.15	4.33	5.85	4.33
20-28S	3.44	4.52	4.70	6.22	4.70
20-29P	2.85	3.93	4.11	5.63	4.11
20-29S	3.89	4.96	5.15	6.67	5.15
20-30P	2.52	3.59	3.78	5.30	3.78
20-30S	3.30	4.37	4.56	6.07	4.56
20-32P	2.26	3.33	3.52	5.04	3.52
20-32S	2.59	3.67	3.85	5.37	3.85
20-33P	2.63	3.70	3.89	5.41	3.89
20-33S	3.00	4.07	4.26	5.77	4.26
20-854P	1.37	2.44	2.63	4.15	2.63
20-854S	1.77	2.85	3.04	4.56	3.04
22-1P	1.93	3.19	3.37	4.89	3.37
22-1S	2.59	3.85	4.04	5.56	4.04
22-2P	2.22	3.48	3.67	5.19	3.67
22-2S	3.04	4.30	4.48	6.00	4.48
22-3P	1.93	3.19	3.37	4.93	3.41
22-3S	2.59	3.85	4.04	5.56	4.04
22-4P	2.19	3.44	3.63	5.15	3.63
22-4S	2.96	4.22	4.41	5.93	4.41
22-5P	2.00	3.26	3.44	4.96	3.44
22-5S	2.63	3.59	4.07	5.59	4.07
22-6P	2.04	3.30	3.48	5.00	3.48
22-6S	2.74	4.00	4.19	5.70	4.19
22-7P	2.04	3.30	3.48	5.00	3.48
22-7S	2.59	3.85	4.04	5.56	4.04
22-8P	1.63	2.89	3.07	4.59	3.07
22-8S	2.04	3.30	3.48	5.00	3.48
22-9P	1.77	2.74	2.96	4.48	2.96
22-9S	2.22	3.48	3.67	5.19	3.67
22-10P	1.74	3.00	3.19	4.70	3.19
22-10S	2.26	3.52	3.70	5.22	3.70
22-11P	1.59	2.85	3.04	4.56	3.04
22-11S	1.96	3.22	3.41	4.93	3.41
22-12P	2.22	3.48	3.67	5.19	3.67
22-12S	3.04	4.30	4.48	6.00	4.48
22-13P	1.96	3.22	3.41	4.93	3.41
22-13S	2.56	3.81	4.00	5.52	4.00
22-14P	3.19	4.44	4.63	6.15	4.63
22-14S	4.41	5.67	5.85	7.37	5.85
22-15P	2.11	3.37	3.56	5.07	3.56
22-15S	2.74	4.00	4.19	5.70	4.19
22-16P	2.56	3.81	4.00	5.52	4.00
22-16S	3.11	4.37	4.56	6.07	4.56
22-17P	2.52	3.78	3.96	5.48	3.96
22-17S	3.00	4.26	4.44	5.96	4.44
22-18P	2.11	3.37	3.56	5.07	3.56
22-18S	2.81	4.07	4.26	5.77	4.26
22-19P	3.30	4.56	4.74	6.26	4.74
22-19S	3.67	4.93	5.11	6.63	5.11
22-20P	2.19	3.44	3.63	5.15	3.63
22-20S	2.96	4.22	4.41	5.93	4.41
22-21P	2.19	3.44	3.63	5.15	3.63
22-21S	2.74	4.00	4.19	5.70	4.19
22-22P	2.56	3.81	4.00	5.52	4.00
22-22S	3.44	4.70	4.89	6.41	4.89

Insert	Shell 3102	3106A	3106B	3108A	3108B
22-23P	$2.52	$3.78	$3.96	$5.48	$3.96
22-23S	3.15	4.41	4.59	6.11	4.59
22-24P	2.07	3.33	3.52	5.04	3.52
22-24S	2.63	3.89	4.07	5.59	4.07
22-25P	2.19	3.44	3.63	5.15	3.63
22-25S	2.74	4.00	4.19	5.70	4.19
22-26P	2.22	3.48	3.67	5.19	3.67
22-26S	2.63	3.89	4.07	5.59	4.07
22-27P	2.41	3.67	3.85	5.37	3.85
22-27S	3.30	4.56	4.74	6.26	4.74
22-28P	2.22	3.48	3.67	5.19	3.67
22-28S	2.78	4.04	4.22	5.74	4.22
22-29P	2.19	3.44	3.63	5.15	3.63
22-29S	2.96	3.81	4.00	5.52	4.00
22-30P	3.19	4.44	4.63	6.15	4.63
22-30S	4.41	5.67	5.85	7.37	5.85
22-32P	2.99	3.26	3.44	4.96	3.44
22-32S	2.63	3.89	4.07	5.59	4.07
22-33P	2.19	3.44	3.63	5.15	3.63
22-33S	2.67	3.93	4.11	5.63	4.11
22-34P	1.96	3.22	3.41	4.93	3.41
22-34S	2.37	3.63	3.81	5.33	3.81
22-35P	2.22	3.48	3.67	5.19	3.67
22-35S	3.04	4.30	4.48	6.00	4.48
22-36P	4.07	5.33	5.52	7.04	5.52
22-36S	5.56	6.81	7.00	8.52	7.00
22-37P	2.22	3.48	3.67	5.19	3.67
22-37S	3.04	4.30	4.48	6.00	4.48
22-404P	7.56	8.81	9.00	10.52	9.00
22-404S	15.15	16.41	16.59	18.11	16.59
24-1P	2.48	3.85	4.00	5.81	4.00
24-1S	3.33	4.70	4.85	6.67	4.85
24-2P	2.52	3.89	4.04	5.85	4.04
24-2S	3.33	4.70	4.85	6.67	4.85
24-3P	2.33	3.70	3.85	5.67	3.85
24-3S	3.15	4.52	4.67	6.48	4.67
24-4P	2.59	3.96	4.11	5.93	4.11
24-4S	3.52	4.89	5.04	6.85	5.04
24-5P	3.67	5.04	5.19	7.00	5.19
24-5S	3.41	5.04	5.19	6.93	5.19
24-6P	2.59	3.96	4.11	5.93	4.11
24-6S	3.56	4.93	5.07	6.89	5.07
24-7P	3.70	5.07	5.22	7.04	5.22
24-7S	4.48	5.85	6.00	7.81	6.00
24-9P	2.56	3.93	4.07	5.89	4.07
24-9S	3.59	4.96	5.11	6.93	5.11
24-10P	3.59	4.96	5.11	6.93	5.11
24-10S	5.26	6.63	6.78	8.59	6.78
24-11P	3.22	4.59	4.74	6.56	4.74
24-11S	4.63	6.00	6.15	7.96	6.15
24-12P	2.96	4.11	4.48	6.30	4.48
24-12S	3.22	5.59	5.74	7.26	5.74
24-14P	2.48	3.85	4.00	5.81	4.00
24-14S	3.44	4.81	4.96	6.78	4.96
24-15P	3.67	5.04	5.19	7.00	5.19
24-15S	4.41	5.77	5.93	7.74	5.93
24-16P	2.56	3.93	4.07	5.89	4.07
24-16S	3.48	4.85	5.00	6.81	5.00
24-17P	2.07	3.44	3.59	5.41	3.59
24-17S	2.85	4.22	4.37	6.19	4.37
24-18P	2.11	3.48	3.63	5.44	3.63
24-18S	2.96	4.33	4.48	6.30	4.48
24-19P	2.74	4.11	4.26	6.07	4.26
24-19S	3.81	5.19	5.33	7.15	5.33
24-20P	2.74	4.11	4.26	6.07	4.26
24-20S	3.74	5.11	5.26	7.07	5.26
24-21P	2.74	4.11	4.26	6.07	4.26
24-21S	3.81	5.19	5.33	7.15	5.33
24-22P	2.85	4.22	4.37	6.19	4.37
24-22S	3.85	5.22	5.37	7.19	5.37
24-23P	3.33	4.78	4.85	6.67	4.85
24-23S	4.15	5.52	5.67	7.48	5.67
24-24P	3.67	5.04	5.19	7.00	5.19
24-24S	4.41	5.77	5.93	7.74	5.93
24-25P	3.59	4.96	5.11	6.93	5.11
24-25S	3.56	4.93	5.07	6.89	5.07
24-26P	2.59	3.96	4.11	5.93	4.11
24-26S	3.56	4.93	5.07	6.89	5.07
24-27P	2.30	3.67	3.81	5.63	3.81
24-27S	3.07	4.44	4.59	6.41	4.59
24-28P	3.96	5.33	5.48	7.30	5.48
24-28S	5.37	6.74	6.89	8.70	6.89
24-835P	2.22	3.59	3.74	5.56	3.74
24-835S	2.96	4.33	4.48	6.30	4.48
24-865P	2.19	13.56	3.70	5.52	3.70
24-865S	4.30	5.67	5.81	7.85	5.81
24-1P	5.56	6.92	7.07	8.63	7.07
24-1S	4.85	6.22	6.63	8.56	6.63
28-2P	3.67	5.33	5.44	7.37	5.44
28-2S	4.52	6.19	6.30	8.22	6.30
28-3P	2.78	4.44	4.56	6.48	4.56
28-3S	3.74	5.41	5.52	7.44	5.52
28-4P	3.74	5.41	5.63	7.44	5.63
28-4S	3.78	5.44	5.56	7.48	5.56
28-5P	3.22	4.89	5.00	6.93	5.00
28-5S	4.15	5.81	5.93	7.85	5.93
28-6P	3.37	5.04	5.15	7.07	5.15
28-6S	4.85	6.52	6.63	8.56	6.63
28-7P	2.96	4.63	4.74	6.67	4.74
28-7S	4.04	5.70	5.81	7.74	5.81
28-8P	3.11	4.78	4.89	6.81	4.89
28-8S	4.22	5.89	6.00	7.93	6.00
28-9P	3.26	4.93	5.04	6.96	5.04
28-9S	4.41	6.07	6.19	8.11	6.19
28-10P	3.85	5.52	5.63	7.56	5.63
28-10S	5.44	7.11	7.22	9.15	7.22
28-11P	5.19	6.85	6.96	8.89	6.96
28-11S	5.74	7.41	7.52	9.44	7.52
28-12P	4.44	6.11	6.22	8.15	6.22
28-12S	5.93	7.59	7.70	9.63	7.70
28-13P	4.44	6.11	6.22	8.15	6.22
28-13S	5.93	7.59	7.70	9.63	7.70
28-14P	3.11	4.78	4.89	6.81	4.89
28-14S	3.93	5.59	5.70	7.63	5.70
28-15P	4.48	6.15	6.26	10.19	8.26
28-15S	7.04	8.70	8.81	10.74	8.81
28-16P	4.44	6.11	6.22	8.15	6.22
28-16S	5.00	6.67	6.78	8.70	6.78
28-17P	3.52	5.19	5.30	7.22	5.30
28-17S	4.07	5.74	5.85	7.78	5.85
28-18P	3.33	5.00	5.11	7.04	5.11
28-18S	3.89	5.56	5.67	7.59	5.67
28-19P	2.96	4.63	4.74	6.67	4.74
28-19S	4.00	5.67	5.77	7.70	5.77

Insert	Shell 3102	3106A	3106B	3108A	3108B
28-20P	$3.70	$5.37	$5.48	$7.41	$5.48
28-20S	5.00	6.67	6.78	8.70	6.78
28-21P	6.78	8.44	8.56	10.48	8.56
28-21S	7.33	9.00	9.11	11.04	9.11
28-22P	3.96	5.63	5.74	7.67	5.74
28-22S	5.30	6.96	7.07	9.00	7.07
32-1P	4.44	7.22	6.30	8.89	6.33
32-1S	6.30	9.07	8.15	10.74	8.19
32-2P	4.44	7.22	6.30	8.89	6.33
32-2S	6.30	9.07	8.15	10.74	8.15
32-3P	5.00	7.78	6.85	9.44	6.89
32-3S	7.22	10.00	9.07	11.67	9.11
32-4P	4.07	6.85	5.93	8.52	5.96
32-4S	5.33	8.11	7.19	9.78	7.22
32-5P	4.07	6.85	5.93	8.52	5.96
32-5S	5.56	8.33	7.41	10.00	7.44
32-6P	5.00	7.78	6.78	10.37	7.81
32-6S	8.70	11.48	10.56	13.15	10.59
32-7P	5.93	8.70	7.78	10.37	7.81
32-7S	8.33	11.11	10.19	12.78	10.22
32-8P	5.26	8.04	7.11	9.78	7.15
32-8S	7.11	9.89	8.96	11.56	9.00
32-9P	4.96	7.78	6.85	9.63	6.89
32-9S	6.96	9.74	7.81	10.41	7.85
32-10P	4.56	7.33	6.41	9.00	6.44
32-10S	6.04	8.81	7.89	10.48	7.93
32-12P	3.96	6.74	5.81	8.41	5.85
32-12S	5.41	8.19	7.26	9.85	7.30
32-13P	5.04	7.89	6.89	9.48	6.93
32-13S	6.85	9.63	8.70	11.30	8.74
32-15P	4.59	7.37	6.44	9.04	6.48
32-15S	6.48	9.26	8.33	10.93	8.37
32-16P	5.93	8.70	7.78	10.37	7.81
32-16S	8.70	11.48	10.56	13.15	10.59
32-17P	4.48	7.26	6.30	8.89	6.33
32-17S	6.85	9.63	8.70	11.30	8.74
32-18P	4.07	6.85	5.93	8.52	5.96
32-18S	5.33	8.11	7.19	9.78	7.22
32-19P	4.44	7.22	6.30	8.89	6.33
32-19S	6.30	9.07	8.15	10.74	8.19
32-20P	5.93	8.70	7.78	10.37	7.81
32-20S	8.70	11.48	10.56	13.15	10.59
32-101P	8.22	11.00	10.04	12.67	10.11
32-101S	10.93	13.70	12.78	15.37	12.81
32-102P	6.97	8.85	7.93	10.52	7.96
32-102S	8.15	10.93	10.00	12.59	10.04
32-103P	5.52	8.74	8.19	10.70	8.41
32-103S	6.85	10.07	9.52	12.04	9.74
36-2P	5.00	8.22	7.67	10.19	7.89
36-2S	7.22	10.44	9.89	12.41	10.11
36-3P	5.19	8.41	7.85	10.37	8.07
36-3S	7.41	10.63	10.07	12.59	10.30
36-4P	4.63	7.85	7.30	9.81	7.52
36-4S	6.85	10.07	9.52	12.04	9.74
36-5P	5.56	8.78	8.22	10.74	8.44
36-5S	7.96	11.19	10.63	13.15	10.85
36-6P	6.11	9.33	8.78	11.30	9.00
36-6S	9.10	12.41	11.85	14.37	12.07
36-7P	7.04	10.26	9.70	12.22	9.93
36-7S	9.63	12.85	12.30	14.81	12.52
36-8P	7.00	10.22	9.67	12.19	9.89
36-8S	9.56	12.78	12.22

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RELAYS! RELAYS! RELAYS!

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Universal general corp.

TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days. All Others Remittance with Order. Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

TELEPHONE TYPE RELAYS

These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations.

107 COOK, 3-6VDC, 6 make, 1 break (5As, 1C), 12 ohm. Part of BC654, #R407..... $ 3.95

CLARE, 6500 ohm, 8maDC, 3 makes (3As), R276 ..... 4.25

5035A7 AUTOMATIC, 1300 ohm, 8maDC, SPST n.o. (1A), #103..... 1.75

A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug, Slow Release, SPDT, 200 ohm. Part of SCR 522, #R365..... 2.49

R5229A1 AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms, Slow Release, #412..... 2.50

R5021A1 AUTOMATIC 1300 ohm, 20maDC, SPST n.c. (1B), #R413..... 2.95

FRAMES

(For Cost of Relay Add Price of Frame to Price of Coil)

Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	1.25	F111	1B, 2A	1.75
F102	2A	1.50	F114	1B, 3A	2.00
F103	3A	1.75	F108	1B, 1A, 1C	2.00
F104	4A	2.00	F107	2B, 1A	1.75
F105	5A	2.25	F112	2B, 2A, 2C	3.00
F106	1A, 1B	1.50	F118	2B, 5A, 1C	3.25
F107	1A, 2B	1.75	F113	5B, 2A	2.75
F108	1A, 1B, 1C	2.00	F121	5B, 1C	2.75
F109	1A, 1C	1.75	F122	1C	1.50
F110	1A, 2C	2.25	F123	2C	2.00
F111	2A, 1B	1.75	F109	1C, 1A	1.75
F112	2A, 2B, 2C	3.00	F116	1C, 4A	2.50
F113	2A, 5B	2.75	F117	1C, 5A	2.75
F114	3A, 1B	2.00	F121	1C, 5B	2.75
F115	3A, 2C	2.75	F110	2C, 1A	2.25
F116	4A, 1C	2.50	F115	2C, 3A	2.75
F117	5A, 1C	2.75	F108	1C, 1A, 1B	2.00
F118	5A, 2B, 1C	3.25	F118	1C, 5A, 2B	3.25
F120	1B	1.25	F112	2C, 2A, 2B	3.00
F106	1B, 1A	1.50			

FRAMES WITH MICROSWITCH

F125	1A, 1C (Microsw.)	1.75
F126	1A, 1A (Microsw.)	1.75

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	1.25	K106	1100/500 Dual	2.00
K102	12	1.25	K111	1300	1.75
K103	250	1.25	K112	2000	2.25
K104	450	1.50	K113	3000	2.50
K105	500	1.50	K114	3600	2.50
K106	500/1100 Dual	2.00	K115	4600	2.75
K107	750	1.50	K116	6500	2.75
K108	900	1.75	K130	11,300	3.00
K109	1000	1.75	K118	40,000	3.25

A-C COILS

Stock No.	Voltage	Price each
K119	6V AC	1.75
K120	24V AC	1.75
K121	110V AC	2.50

SLOW ACTION COILS

Stock No.	Ohms	Slow Action	Price each
K122	33	Make	1.50
K123	75	Release	1.50
K124	200	Release	1.50
K125	300	Make	1.75
K126	2000	Make	2.00
K127	2500	Release	2.00

A = Normally Open; B = Normally Closed; C = Double Throw.

SHORT TELEPHONE RELAYS

A11996 CLARE, (H77519-1) 24VDC, 3PST n.o. (3As), 2900 ohm, #R94..... $ 1.75

6385 ARC 12VDC, SPST n.o. (1A), 10A contact, 200 ohm. Part of **ARC5** or SCR 274N, #R13 ..... 1.50

C58180 BENDIX, 12VDC, DPDT & SPST n.c. (2C, 1B) 150 ohm, **Part of SCR522**, #R58 ..... 2.00

A22268 CLARE, 12VDC, SPST n.o. (1A), 200 ohm, #R411 ..... 1.50

5586 W.E. 12-24VDC, SPST n.o. (1A), 425 ohm, #R414 ..... 1.25

D170788 W.E., 4850 ohm, 8maDC, SPDT, #R92 ..... 2.50

CLARE 24V DC, SPDT(1C), 500 ohm #R278 ..... 2.75

CLARE K102, 6ma DC, 3500 ohm #R30..... 3.49

AUTOMATIC, 1.5V DC, DPST n.c. (2Bs), 5 ohm, #R280..... 3.00

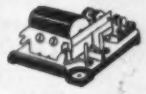
W.E. D169615, 5800 ohm, 6 ma DC, 2Bs, 1C #R261 ..... 2.75

CLARE B16198, 24VDC, 500 ohm IE, #R262.. 3.00

G.M. D282377, 8-12VDC, 90 ohm, 1C, IF (Break, Make, Make) #R363..... 3.00

ULTRA SENSITIVE RELAYS

KURMAN BK35 — Nominal Operating Characteristics, 11,000 Ohms, 0.4 Ma. 4V DC SPDT. Adjustable contacts and armature. #R277, **10 for $55.00. 100 for $475.00.**



$5.95 each

SIGMA 5RJ; 5000 ohms Hermetically sealed SPDT; 1.5 ma. DC, #R281

$6.95 each

KOVAR GLASS TO METAL SEALS HIGH-VOLTAGE FEED THRU

Many types and sizes. Send us your blueprint or sample for our quote. Our prices are a fraction of original factory cost.

SAMPLE KIT 96 Seals (8 ea. 12 types)	5.00	postpaid in USA
LAB KIT 300 Seals (20 types)	15.00	postpaid in USA

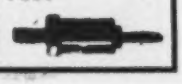
MU-METAL LAMINATIONS

Es, Fs, Is, Ls. Ten Sizes. Quantities Available.

Sample Kit, 6 lbs, Sufficient Quantity of Each Size for One Unit—Postpaid in U. S. A. $19.75

H-F TIE POST

Low-loss Melamine Insulation, pictured actual size (4-40 Thread)....$7.50/C $67.50/M



AMPERITE THERMAL TIME DELAY

Single Pole Normally Open 2.40 ea.

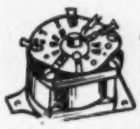
No.	Volts AC/DC	Delay Sec.	No.	Volts AC/DC	Delay Sec.
R946	115	60	R316	24	2
R947	115	30	R950	6	60
R948	115	15	R951	6	30
R943*	115	5	R952	6	15
			R953	6	5

* Edison Type 501

SELENIUM RECTIFIERS

Full-Wave Bridge Types

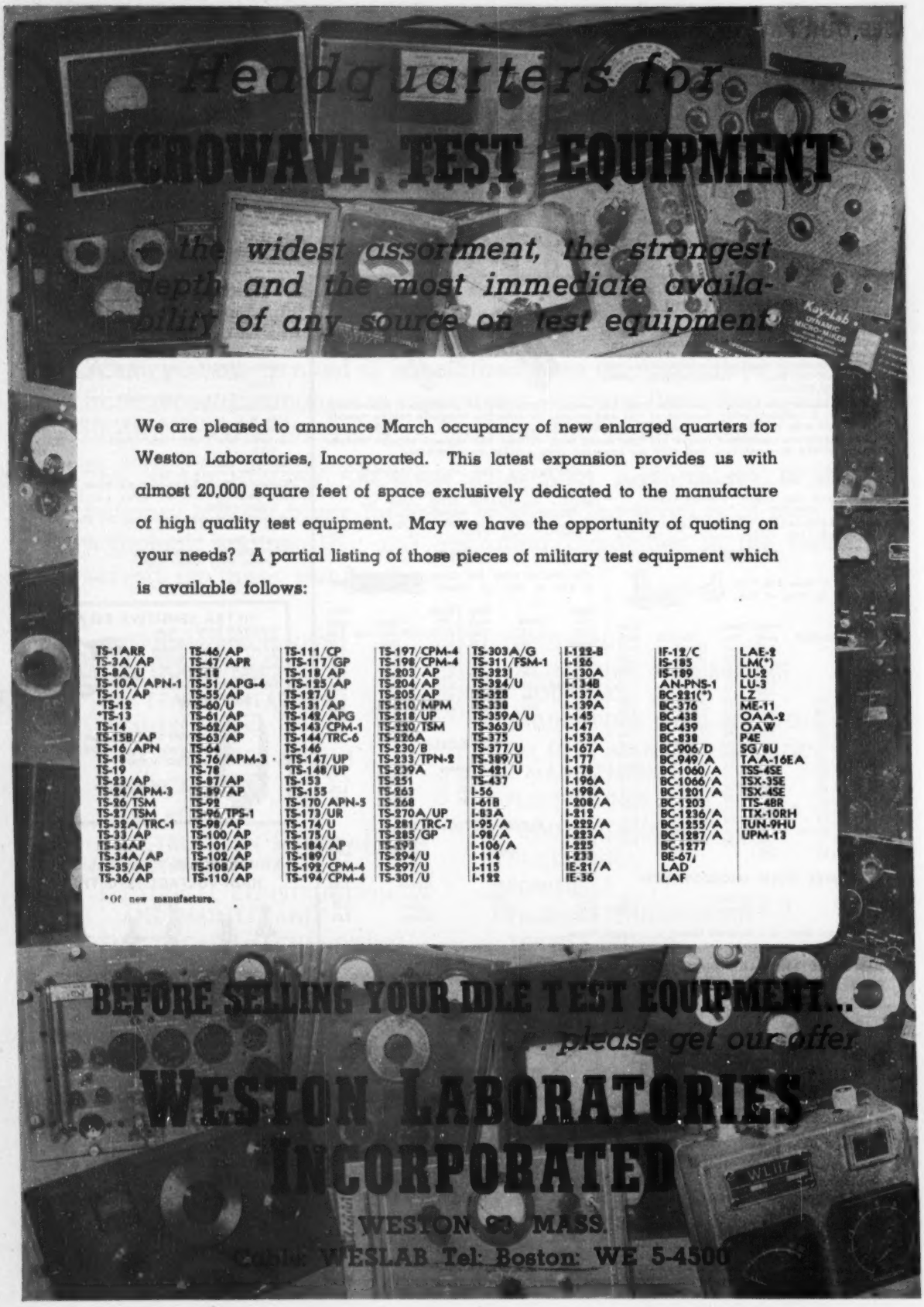
Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.20	$3.60	$8.95
2 Amps.	2.20	3.60	6.50	16.50
2½ Amps.	.....	.....	.....	13.00
4 Amps.	3.75	6.75	8.75	.....
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	36.00
10 Amps.	6.75	12.00	20.00	45.00
12 Amps.	8.50	16.00	25.50	52.50
20 Amps.	13.25	24.00	36.90	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	.....	.....
36 Amps.	25.50	45.00	.....	.....



ROTARY RELAYS

These relays are manufactured by Price Brothers Co. for operation at the voltage indicated. Application of this voltage causes the mechanism to rotate 30°. All are provided with shafts for use with standard wafer switch decks.

Volts D.C.	Ohms	Mfg. No. Price	Mfg. No. Zenith	Switch Decks	Stock No.	Price Each
6	8.3	75-17	——	None	R254	$1.50
6	8.3	75-16A	——	None	R255	1.50
6	8.3	75-15A	——	None	R256	1.50
14	2/125	5228	85G37V 2	Ceramic 1A, 1C 2A, 1B	R257	2.50
14	2/125	4199	85G13V 2	3A, 1C 3B	R258	2.25
28	7/230	75-1	—— 2	3C, 1B 1B, 1C	R259	2.00
28	7/230	77-1	—— 2	2C, 1B 1B	R260	2.00



Headquarters for

MICROWAVE TEST EQUIPMENT

the widest assortment, the strongest depth and the most immediate availability of any source on test equipment

We are pleased to announce March occupancy of new enlarged quarters for Weston Laboratories, Incorporated. This latest expansion provides us with almost 20,000 square feet of space exclusively dedicated to the manufacture of high quality test equipment. May we have the opportunity of quoting on your needs? A partial listing of those pieces of military test equipment which is available follows:

TS-1ARR	TS-46/AP	TS-111/CP	TS-197/CPM-4	TS-303A/G	I-122-B	IF-12/C	LAE-2
TS-3A/AP	TS-47/APR	*TS-117/GP	TS-198/CPM-4	TS-311/FSM-1	I-126	IS-185	LM(*)
TS-8A/U	TS-48	TS-118/AP	TS-203/AP	TS-323	I-130A	IS-189	LU-2
TS-10A/APN-1	TS-51/APG-4	*TS-125/AP	TS-204/AP	TS-324/U	I-134B	AN-PNS-1	LU-3
TS-11/AP	TS-55/AP	TS-127/U	TS-205/AP	TS-328	I-137A	BC-221(*)	LZ
*TS-12	TS-60/U	TS-131/AP	TS-210/MPM	TS-338	I-139A	BC-376	ME-11
*TS-13	TS-61/AP	TS-142/APG	TS-218/UP	TS-359A/U	I-145	BC-438	OAA-2
TS-14	TS-62/AP	TS-143/CPM-1	TS-220/TSM	TS-363/U	I-147	BC-439	OAW
TS-15B/AP	TS-63/AP	TS-144/TRC-6	TS-226A	TS-375	I-153A	BC-838	P4E
TS-16/APN	TS-64	TS-146	TS-230/B	TS-377/U	I-167A	BC-906/D	SG/8U
TS-18	TS-76/APM-3	*TS-147/UP	TS-233/TPN-2	TS-389/U	I-177	BC-949/A	TAA-16EA
TS-19	TS-78	*TS-148/UP	TS-239A	TS-421/U	I-178	BC-1060/A	TSS-4SE
TS-23/AP	TS-87/AP	TS-153	TS-251	TS-437	I-196A	BC-1066/A	TSX-3SE
TS-24/APM-3	TS-89/AP	*TS-155	TS-263	I-56	I-198A	BC-1201/A	TSX-4SE
TS-26/TSM	TS-92	TS-170/APN-5	TS-268	I-61B	I-208/A	BC-1203	TTS-4BR
TS-27/TSM	TS-96/TPS-1	TS-173/UR	TS-270A/UP	I-83A	I-212	BC-1236/A	TTX-10RH
TS-32A/TRC-1	TS-98/AP	TS-174/U	TS-281/TRC-7	I-95/A	I-222/A	BC-1255/A	TUN-9HU
TS-33/AP	TS-100/AP	TS-175/U	TS-285/GP	I-98/A	I-223A	BC-1287/A	UPM-13
TS-34AP	TS-101/AP	TS-184/AP	TS-293	I-106/A	I-225	BC-1277	
TS-34A/AP	TS-102/AP	TS-189/U	TS-294/U	I-114	I-233	BE-67	
TS-35/AP	TS-108/AP	TS-192/CPM-4	TS-297/U	I-115	IE-21/A	LAD	
TS-36/AP	TS-110/AP	TS-194/CPM-4	TS-301/U	I-122	IE-36	LAF	

*Of new manufacture.

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A LEADING SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY -- FULLY GUARANTEED

A. C. SYNCHRONOUS MOTORS

110 Vt. 60 Cycle

HAYDON TYPE 1600, 1/240 RPM
HAYDON TYPE 1600, 1/60 RPM
HAYDON TYPE 1600, 4/5 RPM
HAYDON TYPE 1600, 1 RPM
HAYDON TYPE 1600, 1 1/5 RPM
TELECHRON TYPE B3, 2 RPM
TELECHRON TYPE BC, 60 RPM
HOLTZER CABOT, TYPE RBC 2505, 2 RPM, 60 oz. 1 in. torque.

SERVO MOTORS

PIONEER TYPE CK1, 2 ϕ 400 CYCLE
PIONEER TYPE 10047-2-A, 2 ϕ, 400 CYCLE, with 40:1 reduction gear.

D. C. MOTORS

BODINE NFHG-12, 27 VTS., governor controlled, constant speed 3600 RPM, 1/30 H.P.
DELCO TYP 5068750, 27 VTS., 160 RPM, built in brake.
DUMORE, TYPE EIY2PB, 24 VTS., 5 AMP., .05 H.P., 200 RPM.
GENERAL ELECTRIC, TYPE 5BA10AJ18D, 27 VTS., 110 RPM, 1 oz. 1 ft. torque.
GENERAL ELECTRIC, TYPE 5BA10AJ37C, 27 VTS., 250 RPM, 8 oz., 1 in. torque.
BARBER COLMAN ACTUATOR TYPE AYLC 5091, 27 VTS., .7 amp., 1 RPM, 500 in. lbs. torque.
WHITE ROGER ACTUATOR TYPE 6905, 12 VT., 1.3 amp., 1½ RPM, 75 in. lbs. torque.

AMPLIDYNE AND MOTOR

AMPLIDYNE, GEN, ELEC. 5AM31NJ18A input 27 vts., at 44 amp. output 60 vts. at 8.8 amp., 530 watts.
MOTOR, GEN. ELEC. 5BA50LJ22, armature 60 vts. at 8.3 amp., field 27 vts. at 2.9 amp. ½ H.P., 4000 RPM.

PIONEER AUTOSYNS 400 CYCLE

TYPE AY1, AY5, AY14G, AY14D, AY20, AY27D, AY38D, AY54D.
PIONEER AUTOSYN POSITION.
INDICATORS & TRANSMITTERS.
TYPE 5907-17, single, Ind. dial graduated 0 to 360°, 26 vts., 400 cycle.
TYPE 6007-39, dual Ind., dial graduated 0 to 360°, 26 vts., 400 cycle.
TYPE 4550-2-A, Transmitter, 2:1 gear ratio 26 vts., 400 cycle.

INVERTERS

WINCHARGER CORP. PU 16/AP, MG750, input 24 vts. 60 amps. outputs 115 vts., 400 cycle, 6.5 amp., 1 phase.
HOLTZER CABOT, TYPE 149F, input 24 vts. at 36 amps., output 26 vts. at 230 V.A. and 115 vts. at 500 V.A., both 400 cycle, 1 phase.
PIONEER TYPE 12117, input 12 vts., output 26 vts. at 6 V.A., 400 cycle.
PIONEER TYPE 12117, input 24 vts., output 26 vts. at 6 V.A., 400 cycle.
WINCHARGER CORP., PU/7, MG2500 input 24 vts. at 160 amp., output 115 vts. at 21.6 amp., 400 cycle, 1 phase.
GENERAL ELECTRIC, TYPE 5D21NJ3A, input 24 vts. at 35 amps., output 115 vts. at 485 V.A., 400 cycle, 1 phase.
LELAND, PE 218, input 24 vts. at 90 amps. output 115 vts. at 1.5 K.V.A., 400 cycle, 1 phase.
LELAND, TYPE D.A. input 28 vts., at 12 amp. output 115 vts. at 115 V.A., 400 cycle, 3 phase.

ENGINE HOUR METER

JOHN W. HOBBS, MODEL MI-277 records time up to 1000 hours, and repeats, operates from 20 to 30 volts.

VOLTAGE REGULATOR

LELAND ELEC. CO. TYPE B, CARBON PILE. input 21 to 30 volts D.C. regulated output 18.25 vts. at 5 amp.
WESTERN ELEC. TYPE BC937B, input 110 to 120 volts 400 cycle. Output variation 0 to 7.2 ohms at 5 to 2.75 amps.
WESTERN ELEC, TRANSTAT, input 115 vts., 400 cycle output adjustable from 92 to 115 vts., rating .5 K.V.A.
AMERICAN TRANS. CO., Transtat input 115 vts., 400 cycle output 75 to 120 vts. or 0 to 45 volts, rating .72 K.V.A.

SYNCHROS

1 F SPECIAL REPEATER 115 vt. 400 cycle.
2J1F1 GENERATOR, 115 vt. 400 cycle.
2J1F3 GENERATOR, 115 vt. 400 cycle.
2J1G1 CONTROL TRANSFORMER 57.5 vt. 400 cycle.
2J1H1 DIFFERENTIAL GEN. 57.5/57.5 vt. 400 cycle.
5G GENERATOR, 115 vt. 60 cycle.
5DG DIFFERENTIAL GEN. 90/90 vts. 60 cycle.
5HCT CONTROL TRAN. 90/55 vts. 60 cycle.
5CT CONTROL TRAN. 90/55 vts. 60 cycle.
5SDG DIFFERENTIAL GEN. 90/90 vts. 400 cycle.

TACHOMETER GENERATOR & INDICATOR

GENERAL ELECTRIC, GEN. TYPE AN5531-1, Pad mounting 3 phase variable frequency output.
GENERAL ELECTRIC, GEN. TYPE AN5531-2, Screw mounting 3 phase variable frequency output.
GENERAL ELECTRIC, IND. 8DJ13AAA, works in conjunction with above generators, range 0 to 3500 RPM.

D. C. ALNICO FIELD MOTOR

DIEHL TYPE FD6-23, 27 vts. 10,000 RPM.

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PAB TRANSMITTER 24 VTS.
8TJ11- INDICATOR, dial 0 to 360°, 24 vts.

RECTIFIER POWER SUPPLY

HAMMETT ELECTRIC MFG. CO. MODEL SPS-130. Input voltage 208 or 230 volts, 60 cycle, 3 phase, 21 amps. Output 28 volts at 130 amps. continuous duty, 8 point tap switch, voltmeter ammeter, thermo reset all on front panel.

MISCELLANEOUS

PIONEER MAGNETIC AMPLIFIER ASSEMBLY Saturable reactor type, designed to supply variable voltage to a servo motor such as CK1, CK2, CK5 or 10047.
SPERRY A5 CONTROL UNIT, part No. 644836.
SPERRY A5 AZIMUTH FOLLOW-UP AMPLIFIER, part No. 656030.
SPERRY A5 DIRECTIONAL GYRO, part No. 656029, 115 vt. 400 cycle, 3 phase.
SPERRY A5 PILOT DIRECTION INDICATOR, part No. 645262 contains AY 20.
ALLEN CALCULATOR, TYPE C1, TURN & BANK IND., part No. 21500, 28 vts. D.C.
TYPE C1, AUTO-PILOT FORMATION STICK, part No. G1080A3.
PIONEER GYRO FLUX GATE AMPLIFIER, type 12076-1-A, 115 vt. 400 cycle.

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COMMUNICATIONS EQUIPMENT CO.

SHOCK MOUNT RACKS

FT-146	FT-265A	MT-42/ARC-5
FT-162	FT-338	MT-167-U
	FT-449	
FT-185	FT-487	MT-178A
FT-225	MT-5/ARR-2	MT-171A

SILVER MICA BUTTON COND.

MMF	MMF
40	180
50	185
175	560

PRICE.....$7.00/100
2000 MMF.....15.00/100

CERAMICON TYPE CAPACITORS

MMF	MMF	MMF
24	50	125
15	51	180
20	60	200
27	62	240
30	65	345
47	82	

PRICE..... **$5.00/100**

COAX CABLE

RG8/U
RG9/U
RG14/U
RG17/U
RG57/U

932 PHOTO TUBE

Gas Phototube having SI Response, particularly sensitive to Red and Near Infrared Radiation. Can be used with incandescent light source. Send for data. Price ..... **75¢**

ID-24 ARN-9 Dual 0-200 Microamp. Movement in 3" Case. ILS Equipment $9.95

MICA CAPACITORS

CM-45—2500 V. TEST

MFD.	Price	MFD.	Price	MFD.	Price
.01	$0.85	.0024	.60	.0075	.80
.015	.85	.0025	.60	.0076	.80
.02	.85	.0027	.60	.008	.80
.04	.85	.003	.60	.0085	.80
.001	.60	.004	.60	.0095	.60
.0015	.60	.005	.60	.00985	.60
.002	.60	.0056	.60	.0015	.60
.0022	.60	.006	.60	Write For Many	
.0023	.60	.0063	.60	Others	

CM-55—2500 V. TEST

MFD.	Price	MFD.	Price	MFD.	Price
.00001	$0.29	.001	.35	.0075	1.79
.000025	.29	.0015	.35	.0076	1.79
.00003	.29	.0016	.35	.008	1.79
.00005	.29	.0017	.35	.01	1.10
.000075	.29	.002	.50	.015	1.10
.0001	.29	.0023	.50	.02	1.10
.00015	.29	.003	.50	.025	1.10
.00025	.29	.004	1.79	.027	1.10
.0003	.29	.005	1.79	.03	1.10
.0004	.29	.006	1.79		
.0005	.35	.0063	1.79	5000 V Test	
.00075	.35	.0069	1.79	.0015	1.75
.00085	.35	.007	1.79	.002	2.00

UNIVERSAL SUPPLY KIT

Delivers 230V @ 40MA DC. From 110/220VAC 60 CY. Kit Consists of 1-PWR Transformer, 1-5 HY @ 40MA Choke, 2-8 MFD @ 450V Filter Cond. 1-6x5 Tube. A great buy at only..... **$3.95**

INTERPHONE TRANSFORMER SET

Rig your own interphone. Kit consists of 1-Input Transformer (Matches 4 or 6 OHM SPKR to Grid) and 1-Output Transformer (Matches 50L6, 35L6, 25L6, etc., to 4 or 6 OHM Speaker Set of 2 XMRS. ONLY **$1.00**

12-14V SUPPLY KIT

Delivers 12-14VDC at 3.5A from 115V, 60 cy., Kit contains 1—Transformer Rated 18.5V, 4A, 1—Selenium Rectifier, F. W. Bridge..... **$6.95**

24 VOLT TRANSFORMERS

For operating surplus gear, toy trains, gadgets, etc. Operates from 115V, 60 cy., supplies 24 VAC at 1.2 Amp., herm. sealed and cased..... A Great Buy at Only **$1.49**

RECTIFIER TRANSFORMERS

Pri: 115V, 60 Cy. Sec: 28V/3.1A, 26V/8.4A 7.3V/14A $12.95

Pri. 210/215/220/225/230/235/240V, 60 Cy., 1 Phase Sec: 11/10/7.5/5VCT @ 35A.....$19.50

Pri: 115V 60 Cy: Sec: 8.1V @ 1.5A.....$1.39

Pri: 115V 60 Cy. Sec: 18.5V @ 5A.....$4.25

FLEXIBLE COUPLING SHAFTS

MC 215
(ALL LENGTHS IN INCHES)

24	163	260
135	186	

MC 124

(ALL LENGTHS SHOWN IN INCHES)

23	61	120	175
29	65	140	295
39	103	161	241
F2	114	166	345

PRICE: MC 124 or MC 215

2¢ PER IN.

SELENIUM RECTIFIERS—Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.10	$3.00	$7.50
2 Amps.	2.20	3.60	6.50	10.50
2½ Amps.	.....	.....	.....	13.00
4 Amps.	3.75	.....	8.75	.....
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	33.00
10 Amps.	6.75	12.00	20.00	40.00
12 Amps.	8.50	16.00	25.50	50.00
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	.....	.....
36 Amps.	25.50	45.00	.....	.....

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CTJ5-2	600VCT/.2A, 5V/6A			$5.95
CT-15A	550VCT .085A 6.3V/.6A, 6.3V/1.8A			2.85
CT-164	4200V .002A /12KV Test. 5VCT/3A/12KV Test, 6.3V/0.6A/5400V Test			12.95
CT-341	1050 18 MA.—625V @ 5 MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A			16.95
CR 825	360VCT	.340A	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-626	1500V	.160A	2.5/12, 30/.180	9.95
CT-671	110V	.200A	33/.200,5V/10, 2.5/10	4.95
CT-367	580VCT	.050A	5VCT/3A	2.25
CT-59A	2x110VCT	.010A	6.3/1A, 2.5VCT/7A	1.25
CT-403	350VCT	.026A	5V/3A	2.75
CT-931	585VCT	.086A	5V/3A, 6.3V/6A	4.25
CT-456	390VCT	30 MA	6.3V/1.3A, 5V/3A	3.45
CT-160	800VCT	100 MA	6.3V/1.2A, 5V/3A	4.95
CT-931	585VCT	86 MA	5V/3A, 6.3V/6A	4.95
CT-442	525VCT	75 MA	5V/2A, 10VCT/2A, 58V/200 MA	3.85
CT-720	550-0-550V/250 MA, 6.3V/1.8A			8.95
CT-43A	600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A			6.49
CT7-501	650VCT/200 MA, 6.3V/8A, 6.3V/5A			6.49
CT-444	230-0-230V/.085A, 5V/3A, 6V/2.5A			3.49

Filament Transformers—115V50-60 cps Input

ITEM	Rating	Each
FT-38A	6.3V/2.5A, 2.5V/7A, 2.5V/7A., 7500 VDC Test	$3.45
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/18A, 6.4V/2A	8.95
FT-468	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A, 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A, 7V/7A, TAP 2.5V/2.5A, 16KV Test	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-673	4.5V/.5A, 7V/7A	2.19
FT-899	2x5V A 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

ITEM	Rating	Price
PT-699	300/150V/.05A, 300/150V/.05A	$2.79
PT-302	120-0-120V/350 MA	4.65
PT-108	17,600V/144 MA	120.00
PT-671	62V/3.5A	7.95

Special Fil. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STF-370	220/440	3x2.5V/5A, 3KV Test 2.5V/15A	$6.95
STF-11A	220V	2x440V/.05A, 2x5V/6A 12.6V/1A	4.49
STF-408	220V	24V/0.6A, 5V/3A, 6.3V/1A, 6.3V/3A	3.45
STF-968	230V	2.5V/6.5A	3.50
STF-631	230V	2x5V/27A, 2x5V/9A	17.50

Special Plate Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STP-613	230V	230/.05A,230V/.05A	$1.79
STP-409	220/440V	136VCT/3.5A	5.69
STP-815	240/440, 3ph	1310V/.67A, 8KV Test	27.50
STP-129	230V	3850V/3.12KVA	42.50
STP-823	137V	222VCT/.3A	2.35
STP-88B	50V	2x750V/.001A	1.79
STP-622	210/220/230	5000V/1A	59.75
STP-945	210/220/230	550-0-550V/.3A	5.95

Special Comb. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STC-16A	220V	260V/.03A, 100V/1A, 6.3V/4.2A	$4.69
STC-609	220V	220V/3A	6.95

CIRCUIT BREAKERS

AM 1614—80: 28VDC 80 AMP..... $1.59
AM 1614—100: 28VDC 100 AMP..... $1.69
KJ—600V, 115 AMPS, UP TO 1000% OVERLOAD RATING, TRIP ADJ. 10 MIN.—INST..... $21.95

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE218C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	275	.150	
23350	27	3.75	295	.075	APN-1
ZA6515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK 11
			500	.050	
D-184	12		225	.100	
			440	.050	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.040	APN-1
PE73CM	28	15	1000	.350	BC 376
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.320	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

INVERTERS

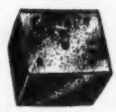
PE-218-H: Input: 25 28 VDC, 92 amp. Output: 115 v, 350 400 cy 1500 volt-amperes. New..... $44.50
PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy, 500 volt-amps. Dim: 13"x5½"x10½". New..... $22.50
LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA, 400 CY 3 PHASE. EXC. COND..... $70.00

This Month's Special

PHASE-SHIFTING HELMHOLTZ COILS 0-360 DEGREES..... $3.95
BLEEDER RESISTOR, TYPE-HA, 3000 OHM—25W, 7500 OHM—5W, 23 OHM—1W, 23 OHM—1W WITH MTG. BRACK... .69¢
SA4A/APA-1 Motor Driven Coaxial Ant. Switch DPDT, Continuous Operation from 24VDC. Completely Enclosed..... $24.50
MP-22 MAST BASE Mobile Antenna Mount 4.59
SA1A/APN-1 Altitude Limit Switch for APN-1 Altimeter..... 7.95
ALTITUDE INDICATOR for APN-1..... 12.50
C-387-D Final P.A. Coil for BC610 2-3.5 MC, Variable Link..... 4.89
RA-74 Power Supply for Super Pro..... 69.50
J-17/ARC-5 Junction Box for ARC-5..... 7.95
J-22/ARC-5 Junction Box..... 3.49
SUPERSONIC CRYSTALS, Rochelle salt..... .50 ea.
MOTOR, 24vdc, 3 HP 3800 rpm, New..... 75.00
TV LEAD-IN WIRE, 300 ohms, HI-Q, Lo-Loss..... $17.50/M FT Roll
BC 306 ANTENNA TUNING UNIT, NEW..... 6.95
R9/APN-4, New, With Tubes..... 75.00
ID6/APN-4, New, With Tubes and Crystal... 75.00
A-62 Phantom Antenna..... 8.50
2 Meter Choke, 1000 MA, 28-144..... 8/ 1.00
Supersonic Crystal Head, M-1, 22-27KC HI-2..... 27.45

FILTER CHOKES

Stock	Description	Price
CH-366	20H/.3A	$6.95
CH-322	.35H/350 MA —10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA.	2.79
CH-69-1	Dual 120H/ 17 MA	2.35
CH-8-35	2 / .5H/380 MA/25 Ohms	1.79



Stock	Description	Price
CH-776	1.28H/130 MA/75 ohms	$2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-511	6H/88MA—310 ohms DCR	2.45
CH3-501	2 x .5H/400MA	2.79
CH-188M	5HY 200MA	1.79
CH-488	10HY .030A	1.19
CH-791	Dual 1.75-.125 HY 100 MA	1.27
CH-981	15HY .110A	1.59
CH-22-1	3 HY .100A	1.17
CH-779	.6 HY .490A	1.25
CH-25A	SW .09/.018 HY 3/.3A	8.95
CH-922	10000 HY O MA	2.75
CH-843	2.2 HY 80 MA	.98
CH-89A	2 x 1.52H @ .167A	1.39
CH-69A	Mult. Choke SECT. 1. Swing 3-12H/.52-.05A SECT. 2. Smooth 5H/.52A SECT. 3. Swing 3.25-18H/.118-014A SECT. 4. Smooth 3.4H/.138A	14.95
CH-445	8.5 HY/200 MA, 32.2 OHMS, 3000V.T.	1.39
CH-170	2X0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5KV INS	39.95

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H/I-Volt Pulse Bulkhead. Feed-thru. Fits UG-36 Connector—as shown $15.00

APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. Pwr out 35 KW Energy 0.018 Joules..... $49.00

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 24 KW (1200 KW pk); pulse rate 200 PPS. 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

PULSE TRANSFORMERS

G.E. # K2731 Repetition Rate: 635 PPS. Pri. Imp: 50 Ohms, Sec. Imp: 450 Ohms, Pulse Width: 1 Microsec. Pri. Input: 9.5 KV PK. Sec. Output: 28KV PK. Peak Output: 800 KW Biflar 2.75 Amp. $65.00

U-10198 Pri: 4-5KV, 97A Pk Sec: 18KV, 26A, PRR-350-500 Cy. Duration 1.3 usec..... $42.50

D-166173: Video. Ration = 50:900 Ohms 10KC—2MC $12.50

G.E.K.-2748 ..... $39.50

G.E.K.-2744-A. 11.5 KV High voltage. 3.2 KV Low voltage @ 200 KW oper. (270 KW max.) 1 microsec. or 1 microsec. @ 600 PPS..... $39.50

W.E. D166271 HI Volt input pulse Transformer..$27.50

G.E. K2450A. Will receive 13KV, 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100 KW G. E. $34.50

G. E. K2748A. Pulse Input line to magnetron.... $36.00

Ray UX 7896—Pulse Output Pri. 5v. sec. 41v.... $7.50

Ray UX 8442—Pulse inversion—40v + 40v..... $7.50

RAY UX7361 ..... $5.00

PHILCO 352-7250, 352-7251, 352-7287

UTAH 9332, 9278, 9341.

RAYTHEON: UX8693, UX5986 ..... $5 ea.

W.E.: D-166310, D-16638, KS 9800, K59948.

DELAY LINES

D-168184: 0.5 microsec. up to 2000 PPS 1800 ohm term $4.00

D-170499: 25/.50/.75 microsec. 8 KV 50 ohms imp. $16.50

D-165997: 1¼ microsec. $7.50

RCA 255686-502, 2.2μ sec. 1400 ohms..... $2.00

PULSE NETWORKS

G.E. #6E3-5-2000-50P2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS 50 ohms impedance $6.50

15A—1-400-50: 15 KV, "A" CKT. 1 microsec. 400 PPS. 50 ohms imp... $37.50

G.E. #3E (3-84-810) (8-2-24-405) 50P4T: 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms Imp; Unit 2, 8 sections, 2.24 microsec. 405 PPS. 50 ohms imp. $6.50

7-5E3-1-200-67P. 7.5 KV. "E" Circuit, 1 microsec. 200 PPS. 67 ohms impedance 3 sections..... $7.50

7.5E3-3-200-6FT. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. 6 ohms Imp. 3 sections..... $12.50

#755: 10KV. 2.2usec., 375 PPS. 50 ohms imp.. $27.50

#754: 10KV. 0.85usec., 750 PPS. 50 ohms imp. $27.50

KS8865 Charging Choke: 115-150H @ .02A, 32-40H @ .08A, 20,700V Corona, 21KV Test..... $37.50

G.E. 25E5-1-350-50 P2T. "E" CKT, 1 Microsec. Pulse @ 350 PPS. 50 ohms impedance..... $49.50

TEST EQUIPMENT

● Signal Gen.	RCA 710A, 370-500 MC	350.00
● Signal Gen.	20A Microvolter	175.00
● TS 18A	Altimeter Test Set	32.50
● TS 16/AP	Altimeter Test Set	
● TS 36	Power Meter, 3 CM.	
● TS 47/APR	Test Osc. 50-3800 MC	325.00
● TS 56/AP	Slotted Line, 500 MC	325.00
● TS 127/UP	Wavemeter, 300-700 MC	72.50
● TS 69/AP	Wavemeter, 348-1000 MC	72.50
● TS 78/AP	Pwr. Meter, 200-500 MC	
● TS 110/AP	Echo Box, 2495-2750 MC	

THERMISTORS

D167018	$1.50
D167332	1.50
D167613	1.50
D166228	1.50
D164699	2.50
D163983	1.95
D166792	2.15

VARISTORS

D171812	$1.50
D172155	1.50
D167176	1.50
D168587	1.50
D167208E, D171855	1.50
308A, 27-B	1.50
D164403	2.15

MICROWAVE COMPONENTS

S BAND—3" x 1½" W.G. 10 CM.

DIRECTIONAL COUPLER, Broadband. 20 db. Coupling. Type "N" Takeoff. Complete with all Hardware. Navy # CABY-47AAN-2..... $37.50

WAVEMETER 2700-3400 MC. Reaction Type with counter Dial—Mfg., W.E. $92.50

REACTION WAVEMETER, Mfg. G.E. 3000-3700 MC. Misc. Head $125.00

LHTR LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B37. Tunable APX 2400-2700 MCS. Silver Plated $49.50

BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice, each. $47.50

MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated..... $45.00

RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr.-TR cavity, compl. recvr. & 30 MC IF strip using 6AK5 (2040, 2C43 1B37 lineup) w/Tubes. **721A TR BOX** complete with tube and tuning plunger $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 ..... $4.00

F 29/SPR-2 FILTERS, type "N" input and output Hi-Pass Over 1000 MC..... $12.50

WAVEGUIDE TO ⅞" RIGID COAX "DOORKNOB" adapter choke flange. Silver plated broad band $32.50

AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

OAJ ECHO BOX, 10 CM TUNABLE..... $22.50

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I. F. AMP STRIP: 30 MC 120 d.b. gain, 2 MC Bandwidth, uses 6AC7's—with video detector. Less tubes $24.50

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ANTENNA. AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed..... $12.50

"E" or "H" PLANE BENDS, 90 Deg. less flanges $7.50

COAXIAL FILTER, F3/APR-2, LO-PASS, BELOW 400 MC $32.50

⅞" RIGID COAX—⅜" I. C.

ROTARY JOINT, Stub-supported, UG 46/UG 45 fittings $27.50

10 CM STABILIZER Cavity, tunable, standard UG46/UP 45 fittings $45.00

RG 44/U RIGID COAX, stub support, 5 ft. sections, with UG46/UG45 connectors $12.50

RT. ANGLES for above..... $4.50

RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00

SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00

RIGID COAX to flex coax connector..... $3.50

RT. ANGLE BEND 15" L. OA..... $3.50

FLEXIBLE SECTION, 15 L. Male to female.. $4.25

⅞" RIGID COAX. BULKHEAD FEED-THRU.. $14.00

X BAND—1" x ½" W.G. 3 CM.

CROSS-GUIDE COUPLER. Main Section 2" long with 90 deg. bend (E-Plane). 2½" radius. Broadbanded coupling figure is 20 db. individually calibrated..$22.50

1" x ½" waveguide in 5' lengths, UG 39 flange to UG40 cover..... $7.50

Rotating joints supplied either with or without deck mounting. With UG40 flanges..... each $17.50

Bulkhead Feed-thru Assembly (As Shown).... $15.00

Pressure Gauge Section 15 lb. gauge and press nipple $10.00

Pressure Gauge, 15 lbs. $2.50

Waveguide Section 12" long choke to cover 45 deg. twist & 2¼" radius, 90 deg. bend..... $4.50

Twist 90 deg. 5" choke to cover w/pres nipple.... $6.50

Waveguide Section 2½ ft. long silver plated with choke flange $5.75

Rotary joint choke to choke with deck mounting.. $17.50

3 cm. mitered elbow "E" plane..... $12.00

UG 39 Flanges ..... $ .85

90 degree elbows, "E" or "H" plane 2½" radius.$12.50

45 degree twist $8.00

APS-4 Under Belly Assembly, less tubes..... $375.00

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SENSITIVITY: 10-13 MICROWATT COMPLETE WITH L.O. AND AFC MIXER AND WAVEGUIDE INPUT CIRCUITS. 6 I.F. STAGES GIVE APPROXIMATELY 120 DB GAIN AT A BANDWIDTH OF 1.7 MC. VIDEO BANDWIDTH: 2 MC. USES LATEST TYPE AFC CIRCUIT. COMPLETE WITH ALL TUBES, INCLUDING 723A/B LOCAL OSCILLATOR $175.00

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APS-34 Rotating joint..... $49.50

Right Angle Bend E or H Plane, specify combination of couplings desired..... $12.00

45° Bend E or H Plane, choke to cover..... $12.00

Mitered Elbow, cover to cover..... $4.00

TR-ATR-Section. Choke to cover..... $4.00

Flexible Section 1" choke to choke..... $6.00

"S" Curve Choke to cover..... $4.50

Adapter, round to square cover..... $5.00

Feedback to Parabola Horn with pressurized window $27.50

90° Twist $10.00

MAGNETRONS

Tube	Tube	Tube
2J27	2J49	720BY
2J31	2J61	725-A
2J21	700	730-A
2J22	706	QK 62
2J26	2J62	QK 61
2J32	3J31	QK 60
2J37	5J30	2J56
2J38	718DY	2J32
2J39		

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(All Primaries 115V, 400 Cycles)

Stock	Ratings	Price
352-7039	648VCT @ 380MA, 6.3V/.9A, 6.3V/6A, 5V/6A	$6.49
702724	9800/9600 @ 32MA.....	8.95
12933	4540V/250MA	17.50
K59584	5000V/200 MA, 5V/10A	22.50
52J652	13,500V/3.5MA	14.65
K59687	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V/6.9A, 6.3V 2.5A 6.3V/.06A, 5V/CA	6.95
352-7070	2X2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/1000/75 CV @ .005A	7.45
352-7196	1140V/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2X6.3VCT/6A	4.75
RA6486-1	2.5V/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901695-581	2.77V @ 4.25A	3.45
901698-581	998V/75MA, 198V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6485-1	800VCT/65MA, 5VCT/3A	3.49
T-48352	700VCT/80MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300 VCT, 135MA	5.95
KS 9116	1186V/58MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.65A, 6.3VCT/.21A..	4.25
KS 8984	27V/4.3A, 6.3/2.9A, 5.25V/.62A	2.95
52C888	526VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	480VCT/35MA, 6.4V/2.5A, 6.4V/.35A	3.85
68G631	1150-0-1150V	2.75
88G138	6VCT/.00006 KVA	1.75
302433A	6.3V/9.2A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/5.1A, 5V/2A..	5.39
KS 9685	6.4/7.5A, 6.4V/1.8A, 6.4V/2.5A	4.79
70G39G1	ALL CT 600VCT/36MA	2.65
M-7474118	2100V/.027A	4.95
95-G-45	20000V/.002A, 465V/.6A, 44V/18A, 6.3V/23.5A, 6.3V/1.8A, 5V/9A, 2X2.5V/1.75	17.95
TRANSTAT IN: 115V, 400 CY. OUT: 75-120V, 6.0 Amps.		12.95
M-7467886	2X140V/.014A, 128V/.012A, 1200VRMS Test, P/O MX-8/APQ-2.....	4.95
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1 MA, 2.5V/1.75A, 6.4V/1.5A, 5V/2A, 6.3V/.3A P/O ID-39/APG-13.....	4.95

MICROWAVE ANTENNA EQUIPMENT

AT49A/APR—Broadband Conical, 300-3300 MC. Type N Feed. (AS SHOWN) $42.50

AS-31/APN-7: 10 cm Polyrod in Lucite Ball. Type N Fitting Coax Feed..$22.50

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½' x 2'. New..... $100.00

Dipole for above..... $12.00

TDY "JAM" Radar rotating antenna, 10 cm. 30 deg. beam, 115 V AC drive. New..... $150.00

Parabolic Peel. Radiation pattern approx 25 deg. in horizontal 33 deg. in vertical planes..... $35.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector..... $14.50

AS14A/AP, 10 CM pick up dipole assy, complete w/length of coax and "N" connectors..... $3.50

AS46A/APG-4 Yagi Antenna, 5 element array.. $22.50

30" Parabolic Reflector Spun Aluminum dish.... $4.85

RADAR ANTENNAS

AS-12/APS-3	AS-125/APR
AS-17/APS-2	AS-217/APG-15
AS-11/APG-2	AT49/APR
AS48/APT	AS-14/AP

30' SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 3 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig. Corps No. 2A329-225-A. New ..... $49.50 per set

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AN/APS-3 Complete	APT-1	RC-1641FF
APS-4 New Complete	APT-2	RC-214
	APT-3	RC-224
	APT-4	RC-256
APR-5	Mark 16	RT34/APS13
APS-6 New. Complete	MD4/APS2	T-85/APT-5
	MD5/APS3	
APS-6 New. Complete	MD22/UPN2	
	MD38/APQ13	

PORTABLE RADAR

Model SQ. 12 cm. Used on small ships. Has PPI indicator. Max. range 20 miles. 1 Kw. output. Operates from 110 VAC, 60 cps. P.U.R.

AN/ART-13 PARTS

Part #	Item
Transmitter	T-47A/ART-13
564016	Barometric Switch
566037	4-Pin Ceramic, Variable Cap.
K7090443	6-Pin Ceramic, Variable Cap
564606	4 Centralab Type 843-003 Cap Assembly
Antenna Loading	CU-25

GAS ENGINE POWER SUPPLY

1½ Kw. 110 V. 60 cps. Complete gas engine power supply. New, with spare parts. P.U.R.

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I-198	TS27/TSM	TS175/UR
BC-638	TS-33	TS182/UP
BC-1255	TS34/AP	TS184A/AP
IE-36	TS-35/AP	TS204/AP
I-95	TS36/AP	TS-218
I-96-A	TS-45A/APM-3	TS251
I-122	TS-59/APN	TS311A/UP
I-130A	TS61/AP	TS323/UP
I-139	TS62/AP	I-146
I-145	TS89	TS-268/U
I-212	TS92	Boonton Mod.
I-232	TS100/AP	78B Sig. Gen.
TS-3A/AP	TS-102	Boonton Type
TS10A/APN	TS111/CP	102F Sig. Gen.
TS12/AP	TS-118/AP	LAD Sig. Gen.
TS16/APN	TS126	LAE-2
TS19/APQ	TS127/U	LAVOIE Freq.
TS-23/APN	TS131	Meter: 300-600 Mc.
TS24A/ARR-2	TS-148/UP	

SUPREME TEST EQUIPMENT

Model 600 Tube and Set Tester.....$89.50
Model 616 Tube and Battery Tester.... 69.50

FLUX METER

For measuring flux density between magnet poles. Has two meters in series with a potentiometer and battery for power supply. Range: 500-4000 Gauss in 3 scales. Requires 1 battery which mounts in case. NEW.....$37.50

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MINE DETECTOR: SCR-625 for prospecting, mining, etc. NEW.....$59.50
LP-21 LOOPS: Mod. LM, AM, A, Excel. cond.

TRANSCEIVER—MODEL 52

5W. 2-way, 2-channel radio transmitter-receiver unit. Complete with tubes, battery charger, microphone. Less crystal and antenna. Operates from 6 V. battery. New.....$89.95

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HS-23	HS-38	TS-13-C
HS-30	TS-10-G	HS-16
HS-33	T-26	EE-8

TRANSTAT

11-5 KVA50/60 cycles. Commutator range 0-115 V. Max. 100 amp. Good cond...$125.00

Specials

RECEIVERS—TRANSMITTERS

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ARC-3	R-9/APN-4	SCR-522
R-4/ARR-2	BC-733-D	TA2J-24
ID-6/APN-4	R-57/ARN	R-89/ARN
MP-10G	BC-788-A-AM-C	R-1/ARR-1

RA-52 RECTIFIER

Transtat controlled to produce high voltage DC from 110 VAC 60 cycle source. Up to 11,500 VDC @ 50 W. Metered high voltage (0-15 KV) and current (10-20 MA). NEW....$74.50

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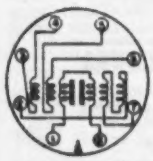
PULSE TRANSFORMER

Tube base plug in type



TYPE UX 7350
Each Coil—50-T #38E
Max. DC Res. Ohms
1 & 8= 4.020
2 & 7=4.8420
3 & 4=2.3570
5 & 6=2.1681

Here are precision made, high quality compact pulse transformers wound on hypersil cores. They are built in octal bakelite tube bases and can be adapted to many uses. They are completely impregnated and sealed.

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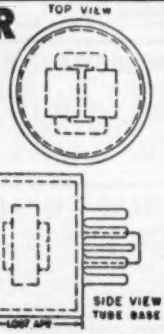
★—Blocking Oscillator, Multivibrator and Scope Circuits.
★—Wherever Accurate Timing and Triggering are necessary.
★—Unexcelled in circuit applications for generating low power and low voltage pulses.
★—Can be used in circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths ranging from .05 Microsecond up.

Price **$4.50** each Immediate Delivery



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$3.29 EACH or 3 for $9.00

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Ampmeter. 2" sq. 0 to 50 amps.....$3.29
2 for $5.00
3" Round Meters. DC. All new. 0 to 15. 0 to 30. 0 to 300 milis...$4.95 each. 3 for $11.95
Milliampmeters. 2½" rd. 0 to 30 milis. Each $3.95
Milliampmeters. 2" rd. 0 to 50 ma. 0 to 5 ma. movement .....$3.29. 3 for $9.00
Thermocouple. 2" rd. 350 ma. RF.....$3.29

Cash with order. California orders please include 3½% Sales Tax. Please include approx. postage. Excess refunded. What have you in surplus? Submit.

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SUPERIOR VALUES FROM
AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE

400 CYCLE MG UNITS

LOUIS-ALLIS 3 UNIT MG SET. Consists of 5 HP motor operative at 220/440-3-60 directly coupled to alternator with output of 115 volts, 1 ph., 400 cyc. and with exciter unit all mounted on steel base. 1.8 K.V.A. Price $565.00

AMERICAN 400 CYCLE SETS. A precision built motor generator set ideal for laboratory test work. Consists of 10 H.P. motor directly connected to alternator with output of 5 KVA, 120/208 Volts, three phase, 400 cycles. With electronic exciter—voltage regulator. Frequ. variation ±5%; Voltage variation±1%; Total harmonic cont. 1.3%. PRICE $1850.00

GENERAL ELECTRIC 400 CYCLE UNITS. Operate at 26 VDC 100 Amp. Output: 115 VAC 1φ, 400 CPS. 1500 V.A. With filter system built-in. Price.... $39.50

WINCHARGER PU-7/AP; Input 28 VDC. 160 Amps. Output:115 VAC. single ph. 2500 V.A. 400 C.P.S. Frequency and voltage regulation built-in. Price... $97.00

WINCHARGER PU-16/AP INVERTER. Type MG750. Input: 28 volts, 60 amp. Output: 115 volts, 6.5, amp., 400 cyc., 1 ph. Brand new. Price..... $69.50

PE 109 INVERTERS. Input 13.5VDC 29A; Output 115V 400 cy. 1.53A 8000 RPM..... $59.95

HOLTZER-CABOT MG218. Compact 2 bearing units for low current 400 cycle output. Operative at 115 VDC, 2.3 amp. Output: 110 Volts, 1.0 amp. 1 ph. 400 CPS. Brand new. PRICE..... $79.50

BOGUE THREE PHASE MG SETS. Consists of Motor 10 H.P. operative at 220/440-3-60 Self-exc. alternator with output of 120/208V. 3φ, 400 cyc. 5 KVA. Brand New ..... PRICE, $1050.00
With Voltage Regulator..... PRICE, $1050.00

8TH 400 CYCLE M-G SETS. Consists of an alternator of 6 KVA with output of 115 volts, 1φ, 400 CPS. V belted drive to 10 HP. motor operative at 220/440-3-60. Excitation provided by dry disk rectifier. Complete with field rheostat. SPECIAL PRICE..... $998.00

LOUIS ALLIS FREQUENCY CHANGER SETS. Pri: 25 H.P. 220/440-3 60; Sec. 15/10.8 K.W. 3300/2200 RPM/ 306/220 Volts 35/85 Amps. 2 ph. 500/360 C.P.S. Brand new. PRICE..... $1250.00
We can supply these units for 400 cycle output and with transformers to supply 3 phase, wye output. Write for further information.

50 K.V.A. 400~ MG SETS

We have been fortunate in acquiring a quantity of **KATO 400 Cycle Alternators** that we have made up into motor generator sets and are thus enabled to offer these at a very attractive price. These sets consist of a 75 H.P. Motor operative at 220/440 Volts, 3 Phase, 60 Cycles, 1750 R.P.M. which are coupled directly to a self-excited alternator with output of 50 KVA, 120/208 Volts, 400 CPS, 3 Phase. These motor-generator sets are BRAND NEW and complete with compensator for motor starting and field rheostat for voltage output control. Voltage regulator can be supplied at $100.00 additional to price as quoted. We will be pleased to supply complete specifications relative to frequency and voltage variation and harmonic content.
SPECIALLY PRICED! $5525.00

G. E. INVERTER UNITS, Model 5AT12IJJ2B; Input: 24 VDC, 55 amp. 8000 RPM. Output: 115 Volts, 3 phase, 400 CPS, 750 VA. and secondary output of 26 Volts, single phase, 400 CPS, 250 VA. With automatic voltage and frequency regulation, built in. Rebuilt and warranted equal to new. Similar to Model 153F.
SPECIAL PRICE $97.50

400 CYCLE COMBINATION I AND 3 PHASE MOTOR GENERATOR. Consisting of 20 HP Synchronous 220/ 440V. Motor V belted to two self excited alternators. Generator I: Bogue 5 KVA 120/208 Volts, 3 Phase, 400 CPS with voltage regulator. Generator II: Onan 4 KVA, 115 Volts, single ph. 400 CPS with voltage regulator. Motor and both alternators and two voltage regulators are mounted on welded channel iron base complete with motor starting compensator. SPECIAL PRICE $375.00

WESTINGHOUSE AMPLIDYNE TYPE MG SEST

Motor: Type CS. Fr. 204, 208 v. 3 ph., 60 cyc., 4 amps. 1.5 HP, directly connected to 2 DC gen. (1) 125 VDC, 2.8 amp., .35 KW. Gen. (2) 250 VDC, 2 amp., sep. exc. 35 volts. The 3 units are contained in one housing. Brand new. The generators have similar characteristic of an amplidyne with a set of control fields and are completely enclosed with rubber gaskets on the enclosing covers, which can be removed for increased KW output. An exceptional value at..... $183.00

WE CAN SUPPLY MOTOR-GENERATOR SETS TO ANY FREQUENCY SPECIFICATIONS AND FOR ANY APPLICATION CONSULT OUR ENGINEERING DEPARTMENT

BRITISH MADE 400 CYCLE SETS. Consists of 10 H.P. Motor, operative at 220-3-60 V-belted to Alternator with output of 6 KVA, 115 V. 1φ, 400~. Complete with GE voltage regulator. Brand new. PRICE $1095.00
MARCONI MG. UNIT. Operates at 110 VDC with output of 250 watts, 115 volts, 1 ph. 300 cyc. With field rheostat for 400~ output. PRICE..... $80.00
400 CYCLE, 3 KVA MG SET. Consists of 5 HP Motor operative at 220-3-60 V-belted to self-exc. alternator with output of 3 KVA, 120 Volts, single ph. 400 cyc. PRICE $588.00
LELAND MG. SET. Consists of 5 HP Motor operative at 220-3-60 direct connected to self exc. alternator with output of 3 KVA, 120/208 V. 3 ph. 400 cyc. PRICE $668.00
GREAT LAKES 400 CYCLE UNIT. Output of 2 KVA, 120 V. single ph. 420 Cyc. with motor operative at 220/440-3-60. Compact two bearing unit. Rebuilt. PRICE $320.00
SPECIAL MG. SET. Motor: 2.5 HP, 220/440-3-60. Self-exc. Alternator with output of 1.25 KVA, 115 V. single ph. 400 cyc. PRICE..... $325.00
GENERAL ELECTRIC 400 CYCLE SET. Motor: 5 HP., 220/400 Volts, 3φ, 60 ~. V-belted to alternator with output of 3 KVA, 220 Volts, 1φ, 400 ~. with exciter and voltage regulator on same base, making completely integral unit. PRICE..... $799.00
KATO MG SET. Motor: 12.5 HP, 220/440-3-60. Output: 7.5 KVA, 230 Volts, 1φ, 350 cyc. with direct conn. exciter. Brand New. PRICE..... $1395.00
PIONEER MODEL GHF175. Input: 11.5 Volts, 34 Amp. Output: 140 Volts, 1.2 Amp. single ph. 350 cycles. 2100 RPM. Supplied with field rheostat to deliver 400 Cycles. PRICE..... $66.50
GENERAL ELECTRIC TYPE PE21BD. Input: 27 VDC, 100 Amp. 8000 RPM. Output: 115 V. 1φ, 400 ~. 1500 VA. Brand new. PRICE $44.50
BOGUE 7.5 KVA MOTOR GENERATOR SET. Motor: 10 HP., 220/440-3-60 direct connected to self-exc. alternator with output of 7.5 KVA, 120/208 Volts, 3 ph. 400 cycles. Wye connected. Harmonic content 1.2%. PRICE $2150.00
With GE Voltage regulator..... $2250.00

800 CYCLE MG UNITS

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3φ, 60 Cy. V belted to self-exc. generator with output of 1.5 KVA, 115 Volts, single ph. 800 CPS, and secondary output of 500 Watts 28.5 VDC 17.5 amperes. PRICE....$375.00
ECLIPSE 800 CYCLE GENERATORS. Flange mounting with spline shaft. Output is 115 VAC 10.4 Amp. 90% P.F. 800 Cycles, 1200 V.A. with secondary output of 28.5 VDC, 60 Amperes. Self excited. PRICE $44.50
H.F. MOTOR GENERATOR, G. E. Model 5LY126A4. Motor: 115 VDC direct connected to Generator 24-32 VDC. 78 amps., and to alternator 120 VAC. 720 cycles, 1 ph. KW-2½..... $289.00
CONTINENTAL DC/AC SET. Motor: 1.5 HP, 250 VDC, 3440 RPM. Output: 120 VAC, 6.6 amps., .8 KW. 800 cyc., 1 ph., also output of 14 VDC, 4 amps., Model CG21637. Compact 2-bear. units. Completely rebuilt. PRICE $114.50
Also available for operation at 115 VDC at the same price. Same set operative at 440 V. 3φ, 60 ~ $119.75
ESCO DUAL FREQUENCY UNITS. Motor operates at 120 VDC, 10 amperes. Delivers 70 Volts at 1200 Cycles or 200 Volts at 720 Cycles. PRICE..... $125.00
BENDIX-ECLIPSE 800 CYCLE AERO UNIT. Input: 24-28 VDC, 75 amps. Output: 115 V. 10.5 Amp. 800 C.P.S. Complete filter system mounted thereon. PRICE $46.75
INVERTER UNIT PE206A. Input: 27.5 VDC, 23 amp. Output: 80 Volts, single ph. 800 CPS. 500 VA. PRICE $42.50

500 CYCLE MG UNITS

BRITISH MADE 500 CYCLE MG SETS. Motor: 230 Volts, 3 PH—50 Cycles. Alternator: 5 K.W. 180 Volts, 27.8 Amp. 500 Cycles, Excitation—110 VDC. When used at 60 Cycle current, Output is 600 cycles, 220 Volts. PRICE $535.00
CROCKER-WHEELER 500 CYCLE MG SET. Compact 2 bearing Unit. Operative at 120 VDC, 7.3 amps. Output: 250 Volts, 5 amp. 500 cycles. Rebuilt. PRICE $88.88
CROCKER-WHEELER 500 CYCLE SET. Operate at 110 Volts, D.C. 29.6 Amps. Output: 120 Volts, single ph. 500 cycles 2.5 KW. PRICE..... $146.95
GE DUAL OUTPUT MG SETS. Consist of Motor rated 3 H.P. 220/440 V. 3φ, 60 Cy. directly coupled to 2 generators. Output .5 K.W. 220 Volts, 2.27 Amp. 525 Cycles. Also .5 K.W. 110 Volts, D.C. 4.55 Amp. 3 separate units mounted on common bed plate. PRICE $150.00
G.E. MG SET MODEL 5LY56AB5A. Motor: 1.1 HP. 250 VDC, 4 amp. Generator: 600 watts, 125 VAC, 4.8 amp., 500 cyc., 1 ph. PRICE $89.50
HOLTZER-CABOT 500 CYCLE MG SET. Motor: 110 VDC. GENERATOR: 5 KVA 230 VAC, 1φ 500 Cyc. Rebuilt. PRICE $271.50

HIGH FREQUENCY UNITS

ELECTRIC SPECIALTY FREQUENCY CHANGERS. Type BF852/BFR8354 Input: 230 Volts, 3 Ph. 60 cy. 3600 RPM. Output: 250 Volts, 20 Amps. single ph. 150 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of HI-cycle equipment. SPECIAL PRICE $160.00
NORMAND ELEC. CO. (BRITISH MFG.) MG UNIT. Motor: 220 VDC. 8.8 amp. 2 HP. 4200 RPM. directly connected to H. F. alternator with output of cyc. 1200 watts. Exc. 24 VDC. PRICE..... $149.00
ELECTRIC SPECIALTY HIGH FREQUENCY CONVERTER UNIT. Primary: 28 VDC, 16 amperes, 8000 R.P.M. Ball Bearings. Secondary: 250 volts, 1500 cycles, .75 amps. 275 V.A. Single Ph. Built-in frequency control. Specially Priced at..... $30.00
BENDIX POWER MG SET. Consists of G.E. 2 HP Rep-Ind Motor, 115 volts, single phase, 60 cyc. directly connected to Bendix alternator with output of 120 volts, 700 cyc., 600 watts and DC output of 14.5 volts, DC, 22 amp. Brand new. PRICE..... $225.00
HIGH FREQ. UNIT. Motor: 24 VDC 50 amp. Alternator: 17 VAC. 1300-1600 cyc. sep. exc. at 24 VDC, 1.25 BHP, 4000 RPM. Made in Canada by Electric Tamper & Equ. PRICE..... $82.50
Alternators only to same specifications as above, sep. exc. at 24 VDC. PRICE $44.50
WESTINGHOUSE 180 CYCLE ALTERNATORS. 750 V.A. Output: 110 Volts, 3 Phase, 180 C.P.S. 3600 R.P.M. Separately excited at 110 VDC. Price.. $65.00
Also available with built-in exciter. Price..... $94.00
GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operating at 440-3-60 .75 amp. Output: 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.5 amperes. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE $46.50
WESTINGHOUSE HIGH FREQUENCY UNITS. Input: 115 Volts, D.C. 3.7 Amps. Autput: 14.4 Volts, .139 Amp. 450-2550 Cycles. Frequency variation is obtained with built-in controller on end of unit. PRICE $48.50
BURKE ALTERNATOR. 62.5 KVA. 230 Volts, 3 Ph. 180 Cycles. 1800 RPM, separately exc. at 125 VDC. 80% P.F. Type ACR-7. Complete with auxiliary exciter MG set and field rheostat. Ball bearings. Will deliver 400 cycles at 4000 RPM. Rebuilt. PRICE....$1375.00
IDEAL FREQUENCY CHANGER SET. Motor operative at 220-3-60 with direct connected induction type alternator with output of 12.5 KVA, 229 V. 3 ph. 180 Cyc. PRICE $445.00
BURKE FREQUENCY CHANGER. Operative at 440-3-60 with output of 12.5 KVA, 230 Volts, 3 ph. 180 cycles. Two bearing machine with direct connected exciter. PRICE $575.00
MARCONI 3 KW UNIT. Operative at 110 VDC, 2400 RPM has output of 3 KW, 500 Volts, 6 amp. 240 cycles. Can be used with field rheostat for 400 other intermediate frequency. PRICE..... $125.00
BRITISH HIGH FREQUENCY UNIT. Operates with input of 110 VDC will deliver 200 watts, with adjustable frequencies up to 10,000 cycles. Controlled by knob at one end of machine. PRICE..... $85.00
ESCO HIGH FREQUENCY MACHINE. Input: 110 Volts, 8 Amp. 2900 RPM. Output: 125 Volts, 8 Amp. 1 KVA, single ph. 580 cycles. PRICE..... $419.75
HOLTZER-CABOT M-G UNITS. Operative at 115 VDC. 8.2 Amp. 1950 RPM. Output: .575 KVA, 55 Volts, 6 Amp. 3 Phase, 195 Cycles. PRICE.... $142.00
HOLTZER-CABOT FREQUENCY CHANGER. Input: 115 Volts, 3 Ph. 60 Cycles. Output: .22 KVA. 70 Volts, 2 Ph. 145 Cycles. PRICE..... $142.00
GENERAL ELECTRIC HIGH FREQUENCY MG. Consists of motor and dual output generator mounted on steel base. Motor operates at 220/440-3-60 direct connected to alternator with output of 115 Volts, 1 Ph. 1050 Cycles, 1 KVA and 115 Volts, DC., 2 KW. With field rheostat. PRICE..... $525.00
WESTINGHOUSE HF UNITS. Input: 115 VDC. Output: 17 Volts, 1050 to 1650 cycles. Variation of frequency accomplished by built in, knob controlled rheostat. PRICE $25.50
GENERAL ELECTRIC 180 CYCLE GENERATORS. We have several 50 KVA units with output of 225 Volts, 3 phase, 180 cycles, 80% PF. with direct connected exciter. Rebuilt and fully guaranteed. PRICE..$600.00

OTHER SPECIAL VALUES

CORNELL DUBILIER VIBRATOR TYPE INVERTER UNITS. Input: 105-125 VDC; Output: 115 VAC, 1φ, 60 cyc. 65 watts, with built-in relay which automatically starts unit with connected load. SPECIAL PRICE $6.90
BACH-SIMPSON ELECTRONIC INVERTER. DC Input: 115 Volts, Output: 115 Volts, 1φ, 60 cyc. 24.5 watts, modified square wave, with built-in relay which automatically turns on inverter with connected load. Contains 8 50L6 GT Tubes. Brand New. SPECIAL PRICE $12.95
ESCO AC MOTORS: built-in magnetic brake for quick reversing. Double shaft, ball bearings. Rated: 2¼ HP— 30 minutes, marine duty: 440-3-60. Brand new in original cases. SPECIAL PRICE..... $37.50
SPECIAL SERIES MOTORS: no name plates, ¾ HP operates at either 110 Volts DC or AC; ¾" shaft. Reconditioned $9.85
WATTHOUR METERS. 110/110 Volt DC operation. Used but in A1 condition. 5 amp..... $3.75
10 amp..... $4.35 15 amp..... $5.00 25 amp..... $6.00
CROMPTON-PARKINSON ALTERNATORS. 3 KVA. .7 PF. 110 VAC, 1φ, 60 cyc. 1800 RPM. sep. exc. PRICE $170.00

WILLIAM I HORLICK COMPANY

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC, IF IT'S FROM ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

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SELENIUM RECTIFIER UNITS

HEAVY DUTY—30 VOLT DC OUTPUT:

115/200 V. Three Phase 400 Cycle Input:
TYPE 143 w/Transformer & VR 100 Amp.....$69.50
TYPE 3FS-8 w/Trans., VR, & Blower—200 Amp.....$69.50
TYPE-32A-11 Rectifier Only, Cased, 200 Amp..$39.50
TYPE A-1 Recifier Only, Cased, 300 Amp....$49.50

BATTERY CHARGING RESISTOR PANEL

115 VDC—6.67 ohms 30 Amps Max. Switching High-Low-& Off. Charging rate: 6-2 Volt Cells: High 30 A.; Low 15 A.—12-2 Volt Cells: 25.8 High; Low 12.7—15-2 Volt Cells: High 23.7; Low 11.6. Complete with Cable. Panel size: 21" x 22" x 10". Mfg. by Ward Leonard—NEW.....Price: $29.95

TRANSFORMERS—100V. 60 Cycle Pri.

5 VOLT CT-25A—10,000 V. Ins. OPEN FRAME—6" x 5" x 4-½".....$7.95
Sec. Two 12 V, 4 A. windings—gives 12 V. 8 A or 24 V. 4 A.....$5.95
Sec. 24 Volt ½ Amp.....1.50
Sec. 24 Volt 1 Amp.....1.95
Sec. 24 Volt 6 Amp.....5.95
Sec. 6-24 or 30 Volts 8 Amp.....5.95

MOUNTING AND CLAMPS:

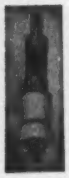
FT-154 for BC-348 Receiver.....$2.50
FT-470 Mounting & Clamp.....1.00
MC-476 Maple Bail for above—f/Fairlead.....1.00
MC-596 Wood Clamp for Fairlead.....75
M-235 Bobbin & 250 Ft. W-106 Antenna Wire..3.50
WT-7 Weight for Training Antenna.....1.50

CORDS—CABLES

C-501 Cord—f/GN-45 Generator.....$2.50
CD-318 Cord w/PL-68 & SW-141 & JK-48F...89
CD-307 Cord 6.5 Ft. w/PL-55 & JK-26.....89
CD-604 Cord w/C-410 Trans. & PL-54 Plug...89
CD-565 Cord for LP-21-Loop.....1.75
MC-215 Tuning Shaft for 274N.....2.00

PLUGS AND CONNECTORS

PL-118 Plug for I-81 and I-82.....$1.50
PL-112 Plug for LP-21 Loop.....1.25
PL-P-103 Plug for BC-348.....1.50
MC-211 Rightangle Adapter for Comm. Sets...50
M-350 Rightangle Coaxial Connector.....25



ANTENNA EQUIPMENT

MAST BASES—INSULATED:

MP-132 BASE—(As illustrated at left) 1" heavy coil spring, 2" insulator. Overall length: 11-½". Weight: 2-¾ lbs. Price.....$3.95

MAST BASE—Insulated type with heavy coil spring and 5" dia. insulator. Requires 1 inch hole for mtg. Weight: 9 lbs.....$5.95

MAST SECTIONS For ABOVE BASES

Tubular steel, copper coated, painted, in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-53-51-50-49 for taper. Any section.....50¢ Each
Larger Diameter Sections: MS-55-54....$1.25 Each.
AN-104B Antenna—100-156 MC.—Copper.....$5.95
AN-104B Antenna—100-156 MC.—Steel.....3.95
AN-104A Antenna—100-156 MC.—Copper.....3.00
AN-104A Antenna—100-156 MC.—Steel.....2.00
AN-117 Whip Steel—6 Ft. length.....1.50
AN-109A Whip Steel, 5 Ft. w-Base.....1.10
AS-27/ANR-5 Ram's Horn, 10 MC.—USED...5.95
AT-27/APT Stub—115-115 MC.....6.95
AT-42/APT-3 or APT-1 Stub—115-150 MC....6.95
AS-97/ARQ-8 Spike with coaxial load in base..4.95
AS-61/ARN-5-Half-Wave Dipole—335 MC....3.95
AT-2/APN-2.....4.95

SELSYN

2J1G1 CONTROL TRANSFORMER WITH CAPS. 57.5 VOLT; 400 CYCLE. NEW: $5.95 Ea.

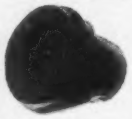
DYNAMOTORS:

DYNAMOTOR and BLOWER: 9 Volts DC input: output 450 Volts 60 MA. 4500 RPM. **At 6 Volts DC** input; output 260 Volts 65 MA. 3600 RPM.....$4.95

Input	Output	Stock No.	Price
14 V. DC	600 V. 300 MA.	BD-36	$8.95
12 V. DC	220 V. 70 MA.	DM-24	6.95
12 V. DC	220 V. 100 MA.	DM-18	4.95
12 or 24 V. DC	440 V. 200 MA. & 220 V. 100 MA.	D-104	14.95
14 V. DC	375 V. 150 MA.	DM-375	8.95
14 V. DC	330 V. 135 MA.	DM-330	7.95
14 V. DC	500 V. 500 MA.	PE-59	14.95
12 or 24 V. DC	275 V. 110 MA.	USA/0516	3.95
12 or 24 V. DC	500 V. 50 MA.	USA/0515	3.95

ALSO—PE-73; PE-86; DM-53; DM-33; 5055; DM-416; PE-101, etc.

BLOWERS:



115 Volt 60 cycle BLOWER (pictured), approx. 100 CFM Dis. 2¼" intake; 2" outlet. Quiet running. Motor size: 2½"x3¼". NEW — not Gov't surplus. Order No. 1C939 **$8.95**

DUAL BLOWER—Same as RN-520 above, except has blower assembly in each side of motor. Order No. 1C880.....$13.95

COMPACT TYPE—108 CFM. motor built inside squirrel cage, 4-½" Intake: 3-⅝" x 3" Dis. Complete size: 4-¼" W x 9-⅝" H x 8-½" D. Order No. 2C067.....$14.50

FLANGE TYPE—140 CFM, 3-½" Intake; 2-½" Dis. Complete size: 8-½" W x 7-¼" H x 6-⅝" D. Order No. 1C807.....$13.95

FLANGE TWIN—275 CFM, 4-½" Intake: 3-¼" x 3" Dis. Complete size: 11-¾" W x 9-⅜" H x 8-1/16" D. No. 2C069.....$21.95

AERIAL WIRE—Phosphorus Bronze #16 Stranded. 200 lb. test. Weatherproof. 150 ft. on Reel. RL-3 with Clips.....$1.50

TELEPHONE WIRE—3 Cond. copper & steel, 525 ft.....$4.75

AIRCRAFT CONTROL CABLE—3/32"—7 x 7 Strand, Weatherproofed, Galvanized, Preformed, 920 lb. test. Ideal for Television Guying and many other uses. Prices: 4-½¢ per Ft.—1000 Ft. or more at 4¢ per Ft.

DC SMALL MOTORS:

27.5 VDC—6000 RPM, 1.5 oz. In. Shaft Size: 1-⅛" x ⅛". Motor Size: 2-½" x 1-½". No. 5069-267.....$6.95

27 VDC—1/10 HP—3500 RPM. Shaft Size: ⅝" x ⅛". Motor Size: 4" x 3-½", Air Assoc. No. EE-763.....$6.95

80 VDC—1/50 HP—3000 RPM. Shaft Size: ⅝" x ⅛". Motor Size: 5" x 3". G. E. No. 5 BN38HA10...$8.95

28.5 VDC—1/35 HP—2200 RPM. Shaft Size: 1-⅛" x ⅛". Motor Size: 4-⅛" x 3-⅝". Electrolux No. 16876.....$5.95

24 VDC—Reversible—3.7 RPM, 40 lb. Torque. Shaft Size: 21/32" x 5/16". Motor Size: 5-⅛" x 4-1/32" x 3-5/16". Also operates 24 VAC. Philco No. 441-1008.....$5.95

MOTOR—GENERATOR:

Navy type CCL-211014, 115 VDC—¾ HP—1750 RPM. Generator 27 VDC, 9.3 Amp. Direct Drive. **Price: $69.50**

Standard Test Leads, 4" x 1-⅛" Prods. Pair: 39¢ — 3 for $1.00
Phone Plug—Nickel Plated, Screw Terminals. Ea.: 39¢ — 3 for $1.00

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Special Purpose and Transmitting Tubes

MX408U	70c	304TL	9.95
RKR 72	48c	450TH	37.50
VT25A/2C25	50c	450TL	62.00
2C26A	40c	708A	1.20
2C34/RK34	60c	715A	6.39
2E22	2.95	715B	7.75
2J21A	9.50	800	1.75
2J31	20.00	801	1.20
2J32	25.00	807	1.35
2J33	25.00	808	2.69
2J34	25.00	813	8.75
2X2/879	74c	826	69c
3BP1	5.95	850	4.20
3DP1	3.95	860	3.95
3E29	12.95	864/VT24	60c
5BP1	3.95	866A	1.59
5BP4	3.95	872	2.75
5CP1	3.95	954	25c
6-9B	1.00	955	35c
C6J	8.95	1089	1.30
6C21	21.95	1090	1.30
7BP7	5.95	1616	69c
10BP4	10.95	1625	35c
12LP4	12.95	1629	25c
100TH	6.95	1632	72c
211	.59	1642	70c
215A/VT5	1.20	1661	90c
250TH	19.95	8020	98c
250TL	16.95	9006	27c

No minimum order

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1T4	.39	6BH6	.49	12BA6	.48
1U4	.48	6BJ6	.45	12BE6	.48
1U5	.39	6BQ6GT	.77	12SN7GT	.77
3A4	.34	6C4	.32	15TS	.76
3Q4	.34	6CB6	.48	25BQ6GT	.77
3S4	.51	6CD6G	1.50	25L6GT	.83
3V4	.52	6V4	.43	25Z5	.43
5U4G	.35	6S6GT	.53	35C5	.43
5Y3GT	.28	6SD7GT	.77	35L6GT	.56
6AG5	.44	6SL7GT	.53	35W4	.36
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6AL5	.36	6T8	.70	80BS	.43
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O1A	write	2J33	100.00	4C27	25.00	304TH	9.75	813	9.00	1625	.65
OC3	$1.60	2J34	write	4C28	35.00	304TL	9.75	829A	12.00	1626	.75
OD3	1.50	2J36	100.00	4C35	27.50	307A	5.00	832A	10.00	1629	.65
C1A	6.00	2J38	49.50	4D32	write	339A	35.00	833A	42.50	1636	3.00
C1B	7.00	2J39	49.50	4E27	17.50	371B	2.50	836	4.75	1642	3.50
C6A	write	2J42	100.00	4J25	175.00	388A	2.75	837	2.75	2050	2.00
C6F	12.50	2J49	100.00	4J26	175.00	446A	2.00	843	write	8012	4.25
C6J	write	2J50	75.00	4J28	175.00	446B	3.75	849	50.00	8020	3.50
1B22	3.95	2J61	75.00	4J29	175.00	450TH	45.00	851	45.00	8025	7.00
1B23	10.00	2J62	75.00	4J30	write	450TL	45.00	860	5.00	9001	1.65
1B24	write	2K22	write	4J31	175.00	464A	9.50	861	write	9002	1.50
1B44	write	2K25	35.00	4J33	190.00	705A	3.25	865	.40	9003	1.75
2B22	4.95	2K26	150.00	4J52	350.00	706AGY	45.00	872A	3.85	9004	1.75
2B26	3.75	2K29	35.00	5C22	write	707B	12.50	874	1.50	9005	1.90
2C40	18.00	2K36	write	5J23	write	714AY	17.50	889R	195.00	9006	.50
2C43	25.00	2K41	150.00	5J26	350.00	715B	17.50	891R	250.00		
2D21	1.70	2K45	100.00	5J29	write	720	write	892	150.00		
2E22	3.75	2K54	150.00	6C21	29.50	721A	3.75	892R	250.00		
2J21	17.50	2K55	100.00	10Y	1.25	723A/B	25.00	2X2/879	1.75		
2J22	17.50	3B24	5.40	100TH	9.00	724B	6.50	K1069P7	write		
2J26	27.50	3B27	10.00	204A	60.00	725A	write	1614	write		
2J27	27.50	3B28	9.00	211	1.00	730A	45.00	1616	2.75		
2J31	27.50	3C31	5.75	250TH	30.00	803	7.00	1619	.75		
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2C46	25.00	E	304A		3.95
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2J33	22.50	C	507AX		1.35
2J34	22.50	O	721A		2.25
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2K23	27.50	P	954		.45
3C24/24G	1.75	A	955		.45
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3GP1	3.75	E	1005		.55
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1B24	11.50	6B6G	.75	705AY-GY	32.50	9004	1.75
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2J50	69.50	15R	1.00	830B	2.95	RK-25	3.69
2J55	84.50	23D4	.65	832	7.95	RK-65	26.50
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4J37	145.00	371B	2.95	1625	2.00		
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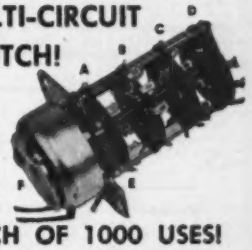

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Torrington #300-101—Black anodized. 3" diam. x 1-1/32" thick. ¼" shaft size. Delivers 63 cfm at 3450 rpm clockwise rotation. **Brand New—Special @ $27.00/C.**

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Lord 100-P-1 Load rating 1 lbs.	$ 6.00/C
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Stewart Warner—748A. 0-20 Amps. Thermal Operation. High Time Lag. Indication follows for average reading as would affect supply transformers. Ideal for design laboratories and industrial motor load checking. **Special at 10 for $30.00.**

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1 ampere DC continuous rating. Filament 2.5 V @ 6.3 amps. New, original boxes. Special @ $350.00 per 100. **Large Quantity Available.**

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ohms	W	Ea.	ohms	W	Ea.	ohms	W	Ea.
.1	150	4.89		50	2.10		150	4.63
.5	25	1.98	60	25	1.45		300	6.93
.5	50	2.34	75	25	1.86	750	25	1.86
.5	150	4.89		50	2.10		150	4.90
1	50	2.34		75	3.25	1000	25	2.10
2	50	2.34	80	50	2.10		50	2.22
2	100	3.86	100	25	1.86	1200	225	6.41
2	300	6.93		50	2.10		300	6.93
3	100	3.86		100	3.60	1250	50	2.22
3	225	6.41	125	25	1.86		150	4.90
5	25	1.86	150	50	2.10	1500	25	2.10
	50	2.10	175	25	1.86		50	2.22
	100	3.86	185	25	1.86	1600	50	2.22
6	25	1.86	200	25	1.86	1850	150	5.15
	50	2.10		100	3.60	2000	25	2.10
	75	3.25		150	4.63		50	2.22
7	25	1.86	225	50	2.10	2250	150	5.15
7.5	75	3.25	250	25	1.86	2500	50	2.22
	225	6.41		50	2.10		100	1.71
8	50	2.10	300	50	2.10		150	5.15
10	25	1.86		75	3.25	3000	25	2.22
	50	2.10		100	3.60		100	3.71
	100	3.60	350	25	1.86	5000	25	2.22
12	25	1.86		100	3.60		50	2.34
	50	2.10	370	25	1.86	7500	50	2.34
15	25	1.86	375	150	4.63		100	4.40
	75	3.25	400	25	1.86	10000	50	2.50
	100	3.60		75	3.25		100	4.75
20	50	2.10	500	25	1.86	15000	25	2.75
22	50	2.10		50	2.10	20000	150	6.98
25	25	1.86		75	3.25			
50	25	1.86		100	3.60			

HIGH POWER TR. MICA

G-1 TYPE					
.0001	6KV	.0005	10KV	.006	10KV
.00015	6KV	.00065	10KV	.015	7KV
.0002	6KV	.001	10KV	.25	1.6KV
.0004	6KV	.002	10KV	G-4 TYPE	
.0008	6KV	.03	2KV	.00025	30KV
.001	6KV	.045	2KV	.0006	35KV
.01	4KV	G-3 TYPE		.0025	25KV
.032	2KV	.0001	20KV	.0039	20KV
.04	1KV	.00015	20KV	.0075	15KV
.051	1.5KV	.00025	20KV	.01	15KV
.08	1.5KV	.0004	20KV	.01083	12KV
.09	1.5KV	.00045	15KV	.03	8KV
G-2 TYPE		.00047	20KV	.056	5KV
.0001	10KV	.0005	20KV	OTHERS	
.00015	10KV	.00095	5KV	.000155	30KV
.0002	10KV	.001	20KV	.0004	30KV
.0003	10KV	.0012	20KV	.000533	30KV
.000375	10KV	.00124	15KV	.001	30KV
.0004	5KV	.0015	20KV	.007	15KV
		.0051	10KV	(Many Others)	

TRANSMITTING MICAS TYPE "4" and "9"

mfd.	wv	type	ea.	mfd.	wv	type	ea.
.0001	600	4	.36	.0015	600	4	.36
.0003	600	4	.36	.00162	600	4	.42
.00005	600	4	.29	.002	600	4	.39
.00005	2500	9	.57	.002	1200	4	.72
.0001	600	4	.29	.0025	600	4	.39
.0001	2500	9	.57	.003	600	4	.43
.00015	600	4	.36	.004	600	4	.45
.0002	600	4	.29	.005	1200	9	.99
.00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.86
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	600	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.08
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

Many other sizes in stock

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TYPE "J" $ .95
TYPE "JL" $1.25 TYPE "JJ" $2.50

ohms	ohms	ohms	ohms	ohms
65*†	4000†	80K†	100-100*	130K-130K*
200†	5000*†	100K*†	500-500*†	150K-150K†
300†	6500*†	125K*	600-600†	100K-200K†
400*†	9000†	150K†	1500-1500*	250K-250K†
500*†	10K*†	165K†	2000-2000*†	300K-300K†
600†	12K†	250K*	2000-50K*	350K-350K*
650*†	15K*†	300K†	2200-25K†	2meg-2meg†
750†	20K*†	400K*	5000-35K†	25K-25K*†
1000*	25K*†	500K†	25K-10K† sw	10K-10K*†
1400†	30K*†	1meg†	2000-20K†	1meg-1meg†
1500*†	50K*†	2meg*†	25K-10K†	5K-5K*†
2000*†	75K†	3meg*	7K-1meg†	400K-400K*
			300K-5K†	500K-500K†
			25K-400K†	50K-50K*†
			1meg-500K†	

Type "JJJ" $4.95

20K-200K-20K†	750K-750K-750K†
45K-27K-2.5K ½sh	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

(*) ⅛" screwdriver slotted shaft. (†) Knob type shaft. (*†) Both types.

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926A	926B2	FROM	926C	926E
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926B	926B14		926C24	930-18
926B1	926B22		926D6	930-21

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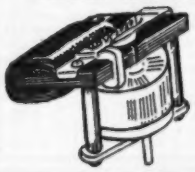

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OA3/VR75	1.10	2J36	110.00	4J30	195.00	RX-21	5.95	250R	8.95	527	12.95	884	10.95	930D	Write
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OB3/VR90	1.60	2J48	27.50	4J41	99.50	FG-32	12.95	250TL	9.95	531	5.75	887	1.50	1005	.69
OC3/VR105	1.80	2J55	85.00	4J52	200.00	45 Spec.	.32	FG-253A	Write	532	2.98	887W	9.95	1006	4.50
OD3/VR150	.90	2J56	149.50	4X150A	27.50	RK47	4.95	FG-258A	Write	559	1.19	888	2.95	1007	.89
1B22	2.25	2J61	39.50	4X500A	85.00	FG-57	13.95	274B	3.25	575	13.95	889	2.95	K1069P7	Write
1B23	8.95	2J62	39.50	C5B	7.50	RK60/1641	1.95	279A	Write	587	Write	810	10.95	1613	Write
1B24	9.50	2K22	39.50	SAP1	4.50					605CX	Write	811	2.90	1616	.99
1B26	2.35	2K23	39.50	SBP1	4.50					609	Write	812	2.75	1619	.39
1B27	14.50	2K25	28.50	SBP4	4.50					KU610	22.00	813	11.95	1624	1.45
1B32	3.10	2K26	79.50	SCP1	4.50					615	Write	814	2.95	1625	.39
1B42	17.50	2K28	32.00	SC22	15.00					632	19.95	815	2.90	1626	.39
1N21B	2.75	2K29	23.95	SD21	19.95					KU676	39.50	826	1.95	1629	.39
1N21C	14.95	2K45	110.00	SFP7	1.95					WL677	39.50	828	9.95	1631	1.50
1N22	1.25	2K46	360.00	SFP14	16.50					708A	16.50	829	9.95	1642	.69
1N23	1.25	2K48	Write	SQP1	4.50					708B	14.95	829B	11.95	1644	.69
1N23A	1.25	2K54	Write	SHP1	6.95					708C	16.50	830B	2.75	2050	1.40
1N23B	1.50	2K55	Write	SHP4	4.95					708D	16.50	832A	9.95	2051	1.10
1N6	7.50	2K56	1.15	SJP1	19.95					701A	4.50	833A	34.95	5514	1.40
1N34	.69	3AP1	8.95	SJP2	19.95					702A	2.75	836	3.45	5516	5.50
1N34A	.79	3B23	4.95	SJP4	19.95					703A	4.25	837	1.45	5523	Write
1N38	1.50	3B24	4.95	SJP5	19.95					704A	Write	838	3.98	5558	175.00
1N48	8.50	3B24W	7.50	SJT3	59.50					705A	1.75	845	8.50	5611	115.00
1N47	4.50	3B26	3.50	SJ39	11.95					706AY	39.50	851	58.00	5635	8.95
1N55	2.75	3B28	6.50	SJ39	39.60					706BY	39.50	852	19.95	5646	8.95
1N56	.89	3BP1	4.95	SR4GY	1.50					706CY	29.50	861	19.95	5651	2.75
1N58A	1.25	3C22	75.00	ST4	1.98					706FY	45.00	864	.39	5654	2.00
1N60	.60	3C23	9.95	C6L/5528	12.50					706GY	45.00	865	.98	5670	4.50
1N61/K63	2.39	3C24/24G	1.50	6AJ5	1.95					707A	7.95	866A	1.50	5672	1.50
1N64	.39	3C27	3.75	6AK5WE	1.50					707B	14.95	866JR	1.25	5676	3.35
1N69	1.10	3C31	3.15	6AL5W	1.75					708A	3.95	869B	53.00	5687	4.25
1Z2	2.95	3C33	9.95	6AN5	1.65					713A	.95	872A	3.25	5694	2.00
V6-2	9.50	3C45	14.95	6AR6	2.25					714AY	8.50	874	1.10	5702	6.50
2C22/1642	.99	3DP1	3.95	6AS6	2.10					715A	6.25	876	.59	5703	1.95
2C39	27.50	3DP1A2	9.95	6BL6	Write					715B	8.95	881	1.50	5704	4.50
2C40	9.95	3E29	13.95	6BM6	Write					715C	22.75	884	1.40	5787	6.00
2C43	15.00	3FP7	1.95	6C21	24.50					717A	.98	889R	139.50	5814	3.25
2C44	1.19	3GP1	3.95	6F4	4.50					719A	24.50	905	3.25	5844	4.50
2C51	6.95	3HP7	3.95	6J4	6.95					720AY	249.50	923	1.25	5915	1.00
2C52	6.95	4-125A	25.00	6N4	1.50					720BY	249.50	927	1.25	5916	2.25
2D21	1.80	4B24	6.95	6SN7WGT	2.50					721A	2.95	931A	5.95	8008	6.95
2D21W	2.49	4C27/CV92	17.50	6SU7GTV	Write					721B	12.50	953B	Write	8012	1.95
2E24	4.65	4C28	35.00	7C23	69.50					722A	1.95	953D	Write	8014A	59.50
2E25A	4.60	4C35	27.25	9LP7	4.95					723A/B	18.95	953E	Write	8020	1.25
2J21A	6.95	4E27	14.95	12AV7	3.00					724B	2.75	954	.33	8025	4.95
2J22	6.95	4J21	129.50	12DP7	16.95					725A	7.50	955	.49	9001	1.25
2J26	14.95	4J22	129.50	12GP7	25.00					726A	Write	956	.49	9002	.98
2J27	14.95	4J23	129.50	12HP7	13.50					726C	59.50	957	.49	9003	1.50
2J31	27.50	4J26	129.50	15E	1.25					738A	25.00	958A	.69	9004	.69
2J32	39.50	4J27	129.50	15R	.49					801A	.39	959	2.95	9005	1.95
2J33	27.50	4J28	129.50	FG-17/5557	3.95					802	3.95	977CX	Write		

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Size ¾" wide x 1-5/16" long. Dovetail mounting—removable lever.

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FT243

Prong centers ½", Prong dia. 3/32"
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2038	2065	6250		8050	
2175	2155	6275	6292	8100	8175
2300		6300	6375	8206	8275
2320	2390	6400	6498	8375	
2420	2490	6500		8385	
2604		6506.6	6575	8400	8475
2605		6600	6675	8575	
3105		6825	6875	8600	8650
3652	3689	6915		8706.25	
3729	3759	6930		8806.75	
3885	3823	6960	6975	8876.25	
	4100	6978.75		8921.25	
4184	4158	7228	7285	9115.0	
4244	4290	7325	7378	9342	9399
4305	4397	7458.75		9405	9499
4400	4480	7440	7475	9500	
4600	4690	7500	7597	9516	9589
4800	4898	7606	7673.3	9608	9638
4913	5095	7625		9675	
5100	5195	7650		12608	12698
5300		7675		12700	12783
5328	5897.5	7700		12800	12890
5500		7725		12902	12998
5630		7731.8		13004	13089
5633.3		7740		13100	13098
5635.5		7751.25		13100	13196
5677.7		7773.75		13213	13295
5700		7775	7790	13302	13361
5706.6	5775	7800		13400	13496
5722.2		7825		13500	13596
5744.4		7850		13597	13696
5800	5892	7875		13903	13996
5900	5975	7900		14038	14092
5955		7925		14120	14198
6025	6075	7950		16585.55	
6150		7975		17170	
6275		7984	7988		
6300	6373.3	8000			

CR 1A/AR or FT241

Prong Spacing ½", Prong dia. ⅛"
Price 79¢ ea. 12 for $9.00

FROM (Frequencies in KC)	TO	FROM (Frequencies in KC)	TO
2853		7620	
3988		7625	
4150		7650	
4286		7738	
4300	4374	7740	
4768		7750	
4820	5090	7760	
5100		7770	
5120	5180	7775	
5200	5295	7778	
5280		7780	
5300	5396	7790	
5410		7800	
5470		7810	
5500		7825	
5468		7830	
5470	5780	7850	
5810		7851	7880
5891		7900	
5910		7910	
5923	5960	7925	
6011	6080	7930	
6130	6195	7940	
6261	6275	7950	
6270		7970	
6300	6375	7975	
6770		7990	
6400	6499	8002	
6490			8010
6500	6590	8007	
6600	6695	8012	
6744			8092
6815	6877	8205	8298
6905	6980	8305	
7140		8309	8370
7270		8407	
7330		8412	
7460		8485	8498
7500		8496	8541
7540		8545	
7541.6		8630	8650
7560		8885	
7600		11677	

FT214A

SPECIAL TYPE WE.
Prong spacing 1" CTS.
Prong Size 3/32" dia.

These are in successive steps of .1 MC variation from 20.0 MC to 27.9 MC

Suitable for low frequency purposes (1/54 of Stated Values)

Price $1.15 ea.

UNASSEMBLED CRYSTALS

consists of quartz crystal plates made for FT243 holders. Furnished complete with holders, electrodes, springs and all hardware.

Price .29 ea.

Crystal plates available in the following frequencies:—

7533	7750	7875	8475
7543		7900	8750
7550	7775	8275	
7640	7800	8325	
7650	7825	8450	
7700	7850		

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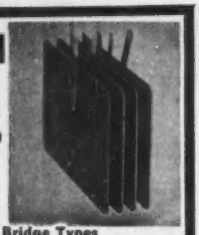

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Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$7.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	.....	.....	6.00	13.00
4 Amps.	3.75	6.75	10.25	.....
5 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	40.00
12 Amps.	8.50	16.25	25.50	45.00
20 Amps.	13.25	25.50	39.00	79.50
24 Amps.	16.25	32.50	45.00	90.00
30 Amps.	20.00	38.50	.....	.....
36 Amps.	25.00	48.50	.....	.....

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PRI: 115 V., 60 cycles in. SEC: 9, 12, 18, 24, and 36 volts | 4 Amps. .....$ 8.75 | 12 Amps. ..... 16.75 | 24 Amps. 35.75

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OD3/VR150	.95	6J6	.59	371-B	.85
OZ4	.59	6K4	3.50	373-A (WE)	4.00
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1AE4	.90	6K7-M	.70	387-A (WE)	2.50
1B3GT	.85	6L6-G	1.19	400-A (WE)	2.50
1B22	2.00	6L7	.80	401-A (WE)	3.50
1B23	8.00	6N7-M	.95	403-B (WE)	7.50
1B27	14.95	6Q7GT	.80	407-A (WE)	5.00
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1N23-B	3.49	6SK7GT	.62	CK512AX	1.25
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3C33	9.00	14F7	.80	1629	.50
3D6/1299	.59	25AV5	1.25	1631	1.50
3Q5GT/G	.99	25BQ6GT	.79	1632	.70
3S4	.80	25L6GT	.64	2050	1.40
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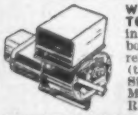
GENERAL ELECTRIC.—DC motor model 5BA50-LJ22, ½ H. P. 400 RPM, 60v-8.3a armature and 27v-2.9a field, reversible and has magnetic brake. Gear Box No. T8254261-G1, has two 100 RPM and one 120 RPM take-offs, controlled by throw-out type clutch. Ball-bearings. Size, less shaft extension, 6x8x13". Wt. 18 lbs. Acquisition cost $207.00. Our price NEW $13.95

EMERSON ELECTRIC.—DC motor type D44FZ-454-0417, 1 H. P. 5800 RPM, 27v-40a armature and 27v-2.5a field, reversible. Throw-out type clutch on gear box controls two 480 RPM take-offs. Ball-bearings. Size 6½x4½x11". Wt. 15½ lbs. Price NEW $12.95



WHITE-ROGER SERVO MOTORS.—24 VDC. Torque 150 in.-lbs. Reversible. Control box on top has limit switches, relays, and selenium rectifiers (to block AC out of motor). Size 5x5x4". Can be supplied in Models 6904-5 RPM or 6904-3½ RPM. Price each NEW..$8.50

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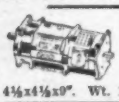

EMERSON ELECTRIC.—Type D44FO447-0417. Can be used as motor or generator. 1 H.P. 5400 RPM. 12 volts 100 amps. Double-end shaft ⅝" dia. by 1-3/16" length on each end. 4½x4½x9". Wt. 17 lbs. Price NEW..... $8.50

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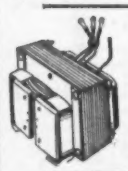

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APA-11 INDICATOR	R-4/ARR-2 Receivers
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MG-149F & H	MG-153

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UG 17/U	UG 35A/U	UG 94/U	CW 155/U	UG 216/U	PL 259A	M 378
UG 18/U	UG 36/U	UG 94A/U	UG 155/U	UG 217/U	UG 259/U	M 3598A
UG 18A/U	UG 37/U	UG 95/U	UG 156/U	UG 218/U	UG 260/U	MT 412
UG 18B/U	UG 37A/U	UG 95A/U	UG 157/U	UG 219/U	UG 261/U	UG 414/U
UG 19/U	UG 38A/U	UG 96/U	UG 158/U	UG 220/U	UG 262/U	UG 421/U
UG 19A/U	UG 39/U	UG 96A/U	UG 159A/U	UG 222/U	UG 266/U	UG 422/U
UG 19B/U	UG 40/U	UG 97/U	UG 160A/U	UG 223/U	UG 269/U	UG 423/U
UG 20/U	UG 45/U	UG 97A/U	UG 160B/U	UG 224/U	UG 270/U	UG 478/U
						UG 479/U
						UG 482/U
						UG 483/U
						UG 484/U
						UG 486/U
						UG 487/U
						UG 491/U
						UG 492/U
						UG 493/U
						UG 494/U
						UG 495/U
						UG 496/U
						UG 499/U
						UG 503/U
						MX 504
UG 20A/U	UG 46/U	UG 98/U	UG 166/U	UG 231/U	UG 271/U	UG 505/U
UG 20B/U	UG 57/U	UG 98A/U	UG 167/U	UG 233/U	UG 272/U	UG 506/U
UG 21/U	UG 57B/U	UG 100/U	UG 167A/U	UG 234/U	UG 273/U	UG 507/U
UG 21A/U	UG 58/U	UG 100A/U	UG 173/U	UG 235/U	UG 274/U	UG 526/U
UG 21B/U	UG 58A/U	UG 101/U	UG 174/U	UG 236/U	PL 274	UG 530/U
UG 21C/U	UG 59/U	UG 101A/U	UG 175U	UG 237/U	UG 275/U	UG 531/U
UG 22/U	UG 59A/U	UG 102/U	UG 176/U	SO 239	UG 276/U	UG 532/U
UG 22A/U	UG 60/U	UG 106/U	UG 180A/U	UG 241/U	UG 279/U	UG 533/U
UG 22B/U	UG 60A/U	UG 107A/U	UG 181A/U	UG 242/U	UG 286/U	UG 535/U
UG 23/U	UG 61/U	UG 107B/U	UG 182A/U	UG 243/U	UG 287/U	UG 538/U
UG 23A/U	UG 61A/U	UG 108/U	UG 185/U	UG 244/U	UG 290/U	MX 554/U
UG 23B/U	UG 83/U	UG 108A/U	UG 188/U	UG 245/U	UG 291/U	UG 557/U
UG 23C/U	UG 85/U	UG 109/U	MX 195/U	UG 246/U	UG 294/U	MX 564/U
UG 27A/U	UG 86/U	UG 109A/U	UG 197/U	UG 249/U	UG 299/U	UG 586/U
UG 27B/U	UG 87/U	UG 110/U	UG 201/U	UG 250/U	UG 306/U	UG 625/U
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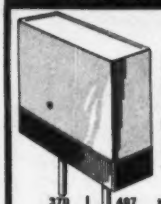

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372	408	445	477	511
374	409	446	479	512
375	411	447	480	513
376	412	448	481	514
377	413	450	483	515
378	414	451	484	516
380	415	452	485	518
381	416	453	486	519
383	418	454	487	520
384	419	455	488	522
385	420	456	490	523
386	422	457	491	525
387	423	458	492	526
388	424	459	493	527
390	425	461	494	529
391	426	462	495	530
392	427	463	496	531
393	429	464	497	533
394	430	465	498	534
395	431	466	501	536
396	433	468	502	537
397	434	469	503	538
398	435	470	504	540
400	436	472	505	
401	437	473	506	
402	438	474	507	
403	440	475	508	
404	441			
405	442			
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4370	6073.3	8200
4440	6075	
4445	6140	
4540	6150	
4580	6350	
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2) 6500 ohms	1C	2 MA	3.00 ea.
3) 6500 ohms	1B-1C	3.5 MA	2.75 ea.
4) 6500 ohms	2A-1B	4 MA	3.00 ea.
5) 6500 ohms	3A	4 MA	3.00 ea.
6) 6500 ohms	3A-1B	4 MA	3.00 ea.
7) 6500 ohms	5A	5 MA	3.25 ea.

CLARE TYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

Coil	Contacts	Will Close at	Price
1) 6500 ohms	2A	5 MA	$2.50 ea.
2) 5800 ohms	3A	4 MA	2.50 ea.
3) 5800 ohms	2B-1C	5 MA	2.50 ea.
4) 4850 ohms	1C	4 MA	2.50 ea.
5) 3600 ohms	1C	6 MA	2.00 ea.
6) 4850 ohms	1A	5 MA	2.00 ea.
7) 3300 ohms	(None)	ACTUATOR	1.50 ea.

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.25	.40	.45	.50	.50	.60	.65
.50	.45	.50	.60	.60	.65	.70
1.0	.50	.65	.75	.75	.85	—
2.0	.85	1.15	—	—	—	—
2 x .05	.35	.40	.45	.40	.45	.60
2 x .10	.40	.45	.50	.45	.50	.65
2 x .25	.45	.55	.65	.50	.65	.75
2 x .50	.55	.65	.85	.60	.75	—
2 x 1.0	.85	.95	—	—	—	—
3 x .05	.40	.45	.50	.45	.50	.65
3 x .10	.40	.45	.65	.45	.50	—
3 x .25	.50	.65	—	.60	.75	—
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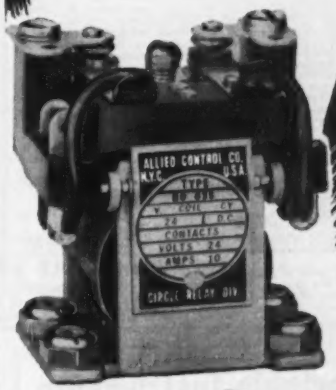

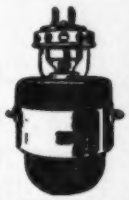

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2D21	1.35	5J26	11.50	6V6GT	.75	327A	4.25	956	.35	9006	.35
2E25	5.00	5R4GY	1.50	6V6GTY	.85	371A	.75	957	.45	CE2	1.50
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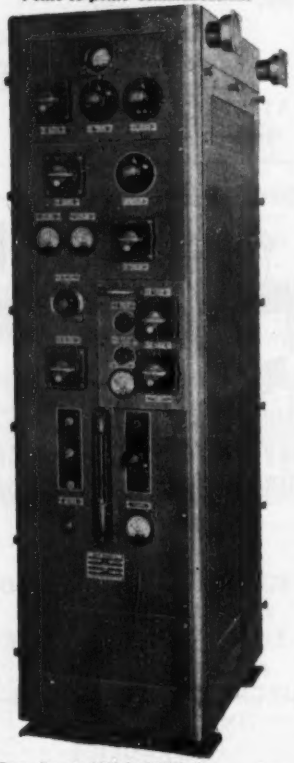

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1B24	13.95	1R4/1294	.79	2K39	135.00	5D21	22.50	6K4	4.90	CK536AX	1.10	829B	12.95
1B27	12.90	2C39	22.95	2K41	149.50	5R4GY	1.55	6L6	2.19	CK537AX	1.25	832A	9.50
1B36	9.50	2C39A	38.00	2K42	142.50			6L6G	1.25	CK538DX	1.25	833A	39.95
1B42	14.95	2C40 Jan	15.95	2K43	139.00			6L6 GAY	2.25	CK542DX	1.15	931A	5.25
1B60	69.50	2C42	25.95	2K44	139.50			6SN7 WGT	2.70	CK543DX	1.20	1620	5.95
1N21/631P1	5.00	2C43	17.95	2K45	145.00			6SU7GTY	2.50	CK544DX	1.15	1622	2.70
1N21	1.20	2C51	6.15	2K46	349.50			12K8Y	.55	CK546DX	1.20	2050	1.49
1N21A	1.70	2D21	1.49	2K47	475.50			FG104	28.50	CK547DX	1.25	5651	2.95
1N21B	2.95	2E24	4.60	2K48	125.00			FG105	18.95	575A	14.50	5654	2.75
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1N23B	3.45	2E43	3.95	3C22	99.50			350-B	4.75	707-B	14.25	5687	5.40
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1N32	24.00	2K25	32.50	3K22	325.00			CK501DX	.75	724A	1.50	5744	1.50
1N34	.65	2K25/723A/B	25.00	3K23	375.00			CK508AX	1.75	724B	3.50	5814	1.50
1N49	7.50	2K26	159.00	4C29	24.00			CK522AX	1.25	726B	49.50	5829	2.50
1N41	9.50	2K28	31.95	4C33	68.00			CK526AX	1.45	726C	59.25	CK5875	1.75
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2J32 2J34 2J37 2J50 2J54 2J54-B 2J61 2K22 2K23 2K25 2K28 2K29 2K33 2K33-A 2K34 2K36 2K43 2K44 2T4-C 3AP1A 3B22 3B23 3B24 3B25 3B26 3BP1 3C21 3C22 3C23 3C24 3C37 3C45 3CP1 3D21-A 3DP1 3DP1-A

3DP1-S2 3E29 3EP1 3FP7 3FP7-A 3GP1 1J30 3JP1 3KP1 4-65A 4B22 4B25 4C35 4D32 4E27 4J32 4J36 4J37 4J61 5AP1 EL5BHD 5BP1 5BP4 5CP1 5C21 5C22 5D21 5FP7 5GP1 GL-5J29 5J30 5JP2 5LP1 5LP5 6AN5 6C21

6C24 6G12 6K4-A 7BP7 7BP7 7C23 7H12/6G12 7JP4 10 10T1 RK-12 13-4 15-E 15-R 19BQ6 RK-28A TUF-20 D-21 REL-21 RX-21 22 23D4 25-T 26 FG-27A 28D7 33 RK-34 35T-G 35-T 36 38 39/44 42 44 44-GA

51-A VR-54 T-55 56 RK-59 RK-60 QK-60 QK-61 RK-65 VR-65 HY-69 71-A CEQ-72 RKR-72 CV-73 RKR-73 B-74 75-T 76 77 CTL-77 FG-81A 82 83-V 85 VR-90 VR-91 FG-95 C-100-E 100-TH HF-100 FG-104 FG-105 VR-105 VU-111 X-111

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CK-501-LX GL-502 527 559 GL-562 575-A HY-615 616 635 651

40 KILOWATT TRANSFORMER AND CHOKE KIT FOR THE PRESS WIRELESS PW-40. NEW

227 RX-233-A 233-A 249-B 249-C 250-R 250-TH 257 267-B 271-A 274-B 300-B HF300 HY-302 304-TH 304-TL 307-A

350-B 385-A CK-359-A 368-AS 371-B 388-A 393-A 394-A 410-R 417-A GL-434-A 446 446-A 446-B 464 GL-471-A

ZP-653 WL-672 700-A 700-D 702-A 703-A 704-A 705-A 706-AY 706-B 706-BY 706-CY 706-GY 706-EX 707-A 707-B 707-BY

708-A 709-A 713-A 714-AY 715-A 715-B 715-C 717-A 719-A 720-CY 721-A 723A/B 724-A 724-B 725-A 726-A 726-C 728-EY 1-800-E 801-A 803 805 807 808 809 810 811 812 813 815 816 822 826 SD-828-A 829

829 829-B 830-B 832 832-A 833 833-A 836 837 838 841 843 849 851 860 CQ-861 864 865 869B 869-BX 872-A 873 874 884 885 SD-917 918 921 925 927 931-A 935 954 955 956 957

958-A 959 966-A CK-1066 CK-1069 CK-1090 R-1130 RK1130-B 1201 1203-A 1232 1273 1294 1299 1299-A 1603 1612 1613 1616 1619 1629 1634 1635 1638 1643 1644 1655

1656 1656-P1 1960 2050 2051 6022 6550 CK-5600 5692 5693 6050 7193 8000 8005 8011 8012 8013 8013-A 8014-A 8016 8020 8025 9002 9003 9004 9005 9006 AX9903 CRC-38022 38089-X 38222 CK-38233 D-79512 VT-25C VT-52 VT-127-A

PULSE TRANSFORMERS

UTAH:		
9250	9340	X 124 T3
9287-D	9350	X 143 T3
9318	X 124 T2	X 146 T1
RAYTHEON:		
UX 7307	UX 7361-A	UX 10066
UX 7350	UX 8052	U 12929
WESTINGHOUSE:		
1P1	132 AW	145 EW
1P2	132 BW	145 EW2
1P4	132 BW2	145 EWP
1P5	132 DW	166 AW
1P26	133 AW	176 AW
1P29	134 EW	381445-1
GENERAL ELECTRIC:		
60GB13	80G58	K 2478
60GB54	80G59	K 2721-A
60G599	80G625	K 2728
60G979	K 2440	K 2746-A
60G13	K 2460	

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MOTOR STARTING CONDENSERS

110 Volts 60 Cycles

POPULAR BRANDS

3276	145-175 mfd	$1.02
95758	161-180 mfg	1.12
3292	162-198 mfd	1.14
3289	180-220 mfd	1.37
3928	200-240 mfd	1.42
3251	218-262 mfd	1.22
3915	234-286 mfd	1.64
3825	243-270 mfd	1.64
3275	243-292 mfd	1.68
3242	324-389 mfd	1.83
3225	400-480 mfd	2.12
3224	485-580 mfd	2.86

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0Y4	$ .45	6K8GT	.65	25A7GT	1.25	5Y3GT	.75	6AL5	.55	6K8GT	.65
0Z4	.45	6K7	.79	25A7GT	1.25	6AB4	.55	6AL5W	.65	6K8GT	.65
1A3	.65	6K7GT	.79	25B6G	1.45	6AB5	.55	6AM4	1.25	6K8GT	.65
1A5GT	.85	6K8	.85	25L6GT	1.07	6AB7	.55	6AM5	.65	6K8GT	.65
1A7GT	.85	6K8GT	.85	25W4GT	.69	6AC5GT	.75	6AM6	.55	6K8GT	.65
1B3	.45	6L6	2.25	25Z5	.69	6AC7	.55	6AN4	1.25	6K8GT	.65
1B3GT	.45	6L6G	1.45	25Z6GT	.67	6AC7A	.55	6AN5	1.25	6K8GT	.65
1C5GT	.85	6L6GA	1.45	27	.39	6AD7	.55	6AN7GT	1.25	6K8GT	.65
1C6	.85	6L6GB	1.45	27A7GT	1.25	6AE5GT	.75	6AN8	1.25	6K8GT	.65
1D5GP	.69	6L7	.85	27GT	.69	6AF4	.55	6AQ5	.55	6K8GT	.65
1D8GT	.69	6L7G	.85	28D7	2.35	6AF4A	.55	6AQ5W	.65	6K8GT	.65
1E5GP	.69	6M4	.75	31	.60	6AF5	.55	6AQ7	.55	6K8GT	.65
1G4GT	.69	6N7	.75	32	.47	6AF6	.55	6AS5	.55	6K8GT	.65
1G5GT	.69	6N7GT	.85	32L7GT	.67	6AG5	.55	6AS6	.55	6K8GT	.65
1G6GT	.69	6Q6	.75	33	.67	6AG7	.55	6AS7G	1.25	6K8GT	.65
1H4G	.75	6Q7	.79	35W4	.49	6AH4	.55	6AT6	.55	6K8GT	.65
1H5GT	.75	6Q7GT	.85	35Z3	.69	6AH6	.55	6AU4GT	.75	6K8GT	.65
1J4	.85	6S7G	.85	35Z4GT	.69	6AK5	.55	6AU5GT	.75	6K8GT	.65
1LA4	.85	6S8	.82	35Z5	.69	6AL3	.55	6AU6	.55	6K8GT	.65
1LB4	.85	6S8	.80	36	.64	6AL5	.55	6AV6	.55	6K8GT	.65
1LC5	.85	6SA7	.85	37	.67	6AL5W	.65	6AX4GT	.75	6K8GT	.65
1LH4	.85	6SA7GT	.85	39/44	.25	6AM4	1.25	6AX5GT	.75	6K8GT	.65
1LN5	.75	6SB7Y	.90	40	.69	6AM5	.65	6B4G	1.25	6K8GT	.65
1N5GT	.75	6SC7	.85	41	.65	6AM6	.55	6B5	.55	6K8GT	.65
1P5GT	.69	6SC7GT	.85	42	.65	6AN4	1.25	6B6G	.75	6K8GT	.65
1Q5GT	.69	6SD7GT	.85	43	.65	6AN5	1.25	6B7	.75	6K8GT	.65
1R4GT	.69	6SF5	.75	45	.65	6AN7GT	1.25	6B8	.75	6K8GT	.65
1R5	.69	6SF7	.75	50B5	.75	6AN8	1.25	6BA6	.55	6K8GT	.65
1S4	.69	6SF7GT	.85	50C5	.75	6AQ5	.55	6BA7	.75	6K8GT	.65
1S5	.69	6SH7	.75	50L6GT	.65	6AQ5W	.65	6BC5	.55	6K8GT	.65
1T4	.69	6SH7GT	.85	50Y6GT	.75	6AQ7	.55	6BC7	.75	6K8GT	.65
1T6GT	.69	6SJ7	.75	50Z6	.75	6AS5	.55	6BD6	.55	6K8GT	.65
1U4	.67	6SJ7Y	.90	50Z7G	.75	6AS6	.55	6BE6	.55	6K8GT	.65
1V	.69	6SK7	.70	70L7	1.35	6AS7G	1.25	6BF5	.55	6K8GT	.65
1X2A	.75	6SK7GT	.75	71A	.65	6AT6	.55	6BF6	.55	6K8GT	.65
1Z2	.75	6SL7GT	.75	75	.62	6AU4GT	.75	6BG6G	1.25	6K8GT	.65
2A3	1.10	6SN7GT	.75	76	.69	6AU5GT	.75	6BH6	.55	6K8GT	.65
2A5	.75	6SQ7	.75	77	.65	6AU6	.55	6BJ6	.55	6K8GT	.65
2X2	2.25	6SN7GTW	2.25	78	.75	6AV5GA	.75	6BK5	.55	6K8GT	.65
2X2A	1.50	6SQ7	.90	79	.75	6AV6	.55	6BL7GT	1.25	6K8GT	.65
3A4	.65	6SQ7GT	.85	80	.65	6AX4GT	.75	6BN6	1.25	6K8GT	.65
3A5	.65	6SR7	.75	81	.75	6AX5GT	.75	6BQ5	.55	6K8GT	.65
3Q5GT	.75	6SR7GT	.85	83	1.10	6B4G	1.25	6BQ6GT	1.25	6K8GT	.65
3S4	.75	6SS7	.75	84	.69	6B5	.55	6BQ7A	.55	6K8GT	.65
3Q5GT	.75	6ST7	.90	85	.69	6B6G	.75	6BS7	1.25	6K8GT	.65
3V4	2.70	6SU7GTY	2.70	86	.75	6B7	.75	6BX6	.55	6K8GT	.65
5Y3GT	1.25	6T8	.85	101A	1.25	6B8	.75	6C4	.55	6K8GT	.65
5U4G	.55	6U4	.75	102A	.90	6BA6	.55	6C5	.55	6K8GT	.65
5U4GW	2.35	6U5	.75	11723	.40	6BA7	.75	6C6	.55	6K8GT	.65
5V4G	.65	6U5GT	.85			6BC5	.55	6C8G	1.25	6K8GT	.65
5W4	.79	6V6	1.07	TRANSMITTING		6BC7	.75	6CB6	.55	6K8GT	.65
5Y3GT	.65	6V6GT	.85			6BD6	.55	6CD6G	1.25	6K8GT	.65
5Y4G	.65	6V6GTY	.90	0A3	.95	6BE6	.55	6CL6	.55	6K8GT	.65
6B8	.75	6W6GT	.75	0A4	2.04	6BF5	.55	6CM7	.55	6K8GT	.65
6A4	.85	6X4	.75	0A4G	1.85	6BF6	.55	6CS6	.55	6K8GT	.65
6A5	.85	6X5	.75	0B2	1.10	6BG6G	1.25	6D6	.55	6K8GT	.65
6A6	.82	6X5GT	.69	0B3	1.10	6BH6	.55	6E5	.55	6K8GT	.65
6A7	.87	6Y6G	.90	0C3	1.10	6BJ6	.55	6F5	.55	6K8GT	.65
6A8	.90	6Z4	.60	0D3	1.10	6BK5	.55	6F6	.55	6K8GT	.65
6A8GT	.95	6Z5G	.80	0Z3	.95	6BL7GT	1.25	6F8G	.55	6K8GT	.65
6AB5	.75	7A4	.75	1A3	2.75	6BN6	1.25	6G6G	.55	6K8GT	.65
6AB7	.75	7A5	.75	1B21A	2.95	6BQ5	.55	6H6	.55	6K8GT	.65
6AC5	1.05	7A6	.75	1B22	2.10	6BQ6GT	1.25	6J5	.55	6K8GT	.65
6AC7	.92	7A8	.75	1B23	2.10	6BQ7A	.55	6J6	.55	6K8GT	.65
6AD7	1.29	7AF7	1.25	1B25	2.75	6BS7	1.25	6J7	.55	6K8GT	.65
6AE5	.85	7B4	.75	1B34	9.00	6BX6	.55	6J7G	.55	6K8GT	.65
6AF4	.85	7B7	.75	1B26	2.75	6C4	.55	6K5	.55	6K8GT	.65
6AG5	.85	7C5	.75	1B27	21.00	6C5	.55	6K6GT	.55	6K8GT	.65
6AG7	1.25	7C6	.75	1B39	2.75	6C6	.55	6K7	.55	6K8GT	.65
6AH6	1.50	7C6	.75	1B32	2.25	6C8G	1.25	6K7G	.55	6K8GT	.65
6AJ5	1.30	7C7	.75	1B35	13.50	6CB6	.55	6K7GT	.55	6K8GT	.65
6AK5	1.30	7E7	.75	1B36	16.75	6CD6G	1.25	6K8	.55	6K8GT	.65
6AL5	1.05	7E8	.75	1B38	20.00	6CL6	.55	6K8G	.55	6K8GT	.65
6AL7GT	1.15	7F8	1.05	1B40	3.95	6CM7	.55	6K8GT	.55	6K8GT	.65
6AN5	2.50	7H7	.75	1B42	17.50	6CS6	.55	6K8GT	.55	6K8GT	.65
6AQ5	.85	7J7	.81	1B50	32.00	6D6	.55	6K8GT	.55	6K8GT	.65
6AQ6	.85	7N7	.85	1B52	32.00	6E5	.55	6K8GT	.55	6K8GT	.65
6AR5	3.35	7S4	.95	1B54	37.50	6F5	.55	6K8GT	.55	6K8GT	.65
6AS5	.85	7V7	.85	1D21	3.95	6F6	.55	6K8GT	.55	6K8GT	.65
6AS6	2.30	7W7	.85	1N21	3.95	6F8G	.55	6K8GT	.55	6K8GT	.65
6AT6	4.50	12A6	.85	1N21A	1.65	6G6G	.55	6K8GT	.55	6K8GT	.65
6AU5GT	1.50	12AQ5	.85	1N21B	1.60	6H6	.55	6K8GT	.55	6K8GT	.65
6AU6	.83	12AT6	.85	1N23	2.25	6J5	.55	6K8GT	.55	6K8GT	.65
6AV5	.95	12AU6	.85	1N23A	2.35	6J6	.55	6K8GT	.55	6K8GT	.65
6AV6	.85	12AV6	.85	1N23B	2.35	6J7	.55	6K8GT	.55	6K8GT	.65
6AX5GT	.85	12AT7	.85	1N26	9.25	6J7G	.55	6K8GT	.55	6K8GT	.65
6BA6	.62	12AU6	.70	1N34	.60	6K5	.55	6K8GT	.55	6K8GT	.65
6BA7	1.35	12AU7	.85	1N34A	.60	6K6GT	.55	6K8GT	.55	6K8GT	.65
6BC5	.85	12AV6	1.75	1N35	1.75	6K7	.55	6K8GT	.55	6K8GT	.65
6BE6	.62	12AW6	1.30	1N36	1.65	6K7G	.55	6K8GT	.55	6K8GT	.65
6BF6	.62	12AX7	.85	1N37	2.25	6K7GT	.55	6K8GT	.55	6K8GT	.65
6BG6G	1.50	12BA6	.69	1N38A	1.35	6K8	.55	6K8GT	.55	6K8GT	.65
6BH6	.90	12BE6	.69	1N60	.60	6K8G	.55	6K8GT	.55	6K8GT	.65
6BQ6GT	1.30	12BH7	42.50	2B21	42.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6B4G	2.25	12BN6	1.01	2AP1	8.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6B7	.95	12C8	.69	2AP1A	10.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6B8	.75	12D6	.69	2B22	2.25	6K8GT	.55	6K8GT	.55	6K8GT	.65
6BE6	.75	12J5	.69	2C21	.95	6K8GT	.55	6K8GT	.55	6K8GT	.65
6C4	.45	12J5GT	.69	2C22	.49	6K8GT	.55	6K8GT	.55	6K8GT	.65
6C5	.60	12K7GT	.75	2C26A	.95	6K8GT	.55	6K8GT	.55	6K8GT	.65
6C5GT	.75	12K8	.72	2C33	1.85	6K8GT	.55	6K8GT	.55	6K8GT	.65
6C6	.69	12K8Y	.90	2C34	27.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6C8	.75	12SA7	.76	2C39	37.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6CB6	.62	12SA7GT	.79	2C39A	37.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6D6	.72	12SC7	.85	2C40	7.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6D8	.75	12SF5	.75	2C43	18.00	6K8GT	.55	6K8GT	.55	6K8GT	.65
6E5	.75	12SF7	.85	2C50	4.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6F5	.62	12SQ7	.85	2C51	6.25	6K8GT	.55	6K8GT	.55	6K8GT	.65
6F5GT	.62	12SH7	.65	2C52	2.75	6K8GT	.55	6K8GT	.55	6K8GT	.65
6F6	.80	12SJ7	.85	2C53	11.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6F6GT	.80	12SK7	.75	2D21	1.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6F8G	.75	12SK7GT	.75	2E22	3.50	6K8GT	.55	6K8GT	.55	6K8GT	.65
6G6	.90	12SL7GT	.72	2E30	2.00	6K8GT	.55	6K8GT	.55	6K8GT	.65
6G6G	.90	12SN7GT	.72	2E31	2.10	6K8GT	.55	6K8GT	.55	6K8GT	.65
6H6	.55	12SQ7	.72	2E32	2.25	6K8GT	.55	6K8GT	.55	6K8GT	.65
6H6GT	.55	12SQ7GT	.72	2E36	2.25	6K8GT	.55	6K8GT	.55	6K8GT	.65
6J5	.65	12Z3	.75	2E41	2.35	6K8GT	.55	6K8GT	.55	6K8GT	.65
6J5GT	.65	14A7	.85	2E42	2.65	6K8GT	.55	6K8GT	.55	6K8GT	.65
6J6	.90	14B7	.85	2G21	2.20	6K8GT	.55	6K8GT	.55	6K8GT	.65
6J7	.80	14J7	.85	2C32	2.20	6K8GT	.55	6K8GT	.55	6K8GT	.65
6J7GT	.80	19D8GG	1.49	2J21A	7.50	6K8GT	.55	6K8GT	.55	6K8GT	.65

2J22	9.00	FG104	24.95	829B	23.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J26	25.00	FG106	24.95	832	9.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J27	25.00	VU111B	1.00	832A	9.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J30	69.50	114B	2.35	833A	37.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J31	37.00	RK120A	24.50	836A	13.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J32	37.00	F123A	26.50	836	4.65	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J34	32.00	F124A	26.50	837	1.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J35A	37.50	VT127	1.95	838	2.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
2J42	37.50	VT127A	2.75	841	.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K22	45.00	F126A	24.95	842	.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K25	52.50	FG172	29.95	845	1.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K26	52.50	GL2050A	12.00	846	10.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K28	29.95	208D	1.25	849	10.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K29	29.95	204A	49.50	851	75.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K30	29.95	207	250.00	852	37.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K39	285.00	211	1.45	857B	225.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K41	150.00	CE211	2.50	860	4.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K45	135.00	VT7C	16.95	861	29.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2K50	98.00	RK323A	1.95	864	.35	6K8GT	.65	6K8GT	.65	6K8GT	.65
2RA5	1.95	FG258A	72.50	866	2.10	6K8GT	.65	6K8GT	.65	6K8GT	.65
2V3G	3.95	209B	7.95	866A	1.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
2X2	.75	250TH	21.50	868	2.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2X2A	1.25	250TL	19.00	869B	61.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
3A4P	1.25	264C	3.45	872A	4.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
3A5	4.75	267B	5.25	874	1.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
3B24	5.50	270A	90.50	885	2.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
3B24W	5.50	267B	5.25	889	1.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
3B28	6.75	270A	90.50	908	3.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
3B27	4.25	FG271	57.50	912	15.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
3B28	14.50	274B	920	2.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
3BP4	7.50	FG280	59.50	926	2.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
3CP1	4.75	282A	927	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
3DP1A	6.75	304TH	13.50	929	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
3C24	1.95	304TL	11.95	930	1.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
3C27	307A	4.95	931A	6.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
3C28	3.95	309A	85.00	954	4.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
3C35	CK309	5.25	954	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
3C45	18.50	310A	6.50	955	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
3C48	9.50	311A	956	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
3D21	2.50	313C	4.20	957	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
3E29	34.95	316A	2.00	959	2.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
3E50	3.95	319A	21.25	991	.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
3FP7A	14.00	323B	12.50	CK1005	.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
3GP1	6.95	320A	4.75	CK1017	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
4-65A	15.00	321A	3.50	CK1089	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
4C31	136.00	446A	1.75	CK1090	.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
4D32	195.00	446B	14.75	R1111	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
4D34	195.00	446D	14.75	R1181C	7.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
4E32	225.00	450TH	45.00	E1148	7.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
C6B	4.25	450TL	65.00	1201	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
5BP1	5.75	4644A	4.75	1203A	.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
5CP1	4.50	471A	12.50	1206	.89	6K8GT	.65	6K8GT	.65	6K8GT	.65
5D21	18.15	GL803A	1.00	1274	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
5FP7	2.50	500	37.50	1614	2.10	6K8GT	.65	6K8GT	.65	6K8GT	.65
5FP7A	12.50	582A	1.75	1616	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
5FP14	27.50	649	34.95	1619	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
5JP1	27.50	650	1.75	1621	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
5LP1	27.50	651	1.75	1622	2.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
5LP2	15.00	WL810	45.00	1623	4.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
5LP3	14.50	617	11.00	1625	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
5RP1A	27.50	KU628	32.50	1626	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
5RP2A	37.50	F631	1627	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
5RP7	1.75	FG632A	1629	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
5R4WGY	3.25	640	6.95	2050	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
5UP11	22.50	651/656	69.00	2051	1.15	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AB4	2.55	705C	17.50	4126/5855	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AK5	1.30	653	5.95	R4330	12.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AN5	3.15	672A	34.50	R4410	18.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AS6	2.95	QL676	5828/C6L	10.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AB6	2.95	703A	2.35	5857	7.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AB7	4.50	706AY	55.50	5559	18.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AC7	4.50	708DY	55.50	5651	2.35	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AH6	75.00	706GT	55.50	5654	4.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AK6	7.95	707A	16.25	5659	6K8GT	.65	6K8GT	.65	6K8GT	.65
6AL5	49.50	707B	19.25	5660	6K8GT	.65	6K8GT	.65	6K8GT	.65
6J6	6.95	708A	4.75	5663	3.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
6K4	4.50	709A	3.85	5663	2.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
6L6	8.95	713	1.00	5664	6K8GT	.65	6K8GT	.65	6K8GT	.65
6LP7	37.50	714AY	12.50	5670	7.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
10Y	.65	715	5.00	5691	8.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
12DP7	17.50	715B	5.75	5692	8.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
12QP7	17.50	715C	12.50	5693	8.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
12RP7	17.50	716C	24.50	5732	6K8GT	.65	6K8GT	.65	6K8GT	.65
CK18	.70	717A	2.75	5749	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
45E	1.85	718BY	75.50	5751	1.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
10R	1.65	719A	42.50	5782	1.65	6K8GT	.65	6K8GT	.65	6K8GT	.65
10Y	6.25	720CY	61.00	5803/VX-34	6.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
RK30A	6.25	721A	4.50	5814	1.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
24G	1.85	722AB	22.50	5836	4.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
25T	1.00	724A	2.75	5871	6K8GT	.65	6K8GT	.65	6K8GT	.65
FG-27A	23.50	724B	13.50	5881/6U4WG	4.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
28D7	2.35	728A	9.50	X6089	1.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
FG32	15.00	726A	14.50	UX6683	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C21	15.00	726C	75.00	7193/2C22	.49	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C22	.49	FK34	85.00	8729	3.25	8002B	101.00	6K8GT	.65	6K8GT	.65
2C26A	.95	35T	9.00	730A	28.95	8011	1.00	6K8GT	.65	6K8GT	.65
2C33	1.85	35TG	9.00	WL762	8012	1.00	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C34	27.50	35TIG	9.00	801A	.85	8013	1.35	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C39	37.50	CE56C	802	4.20	8013A	9.50	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C39A	37.50	RK39	14.50	803	14.50	8025	5.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C40	7.50	EF50	1.50	804	16.50	8026	5.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C43	18.00	52A	2.95	805	5.95	9001	1.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C50	4.50	FG67	14.35	806	17.50	9002	.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C51	6.25	56A	1.35	807	1.65	9003	1.55	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C52	2.75	QK59	65.00	807W	3.25	9004	.55	6K8GT	.65	6K8GT	.65	6K8GT	.65
2C53	11.50	RK60	808	5.95	9005	2.25	6K8GT	.65	6K8GT	.65	6K8GT	.65
2D21	1.50	FG67	22.50	809	3.50	9006	.45	6K8GT	.65	6K8GT	.65	6K8GT	.65
2E30	2.00	CEQ75	.85	810	13.50	AX9903	6K8GT	.65	6K8GT	.65	6K8GT	.65
2E31	2.10	RK75	1.75	811	2.95	6K8GT	.65	6K8GT	.65	6K8GT	.65
2E32	2.25	RK78	4.75	812	4.75	6K8GT	.65	6K8GT	.65	6K8GT	.65
2E36	2.25	FG81A	9.25	813	13.50	6K8GT	.65	6K8GT	.65	6K8GT	.65

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Elec Spec Type 1A1, Spec 32159D, 24 VDC, 15A, ¼HP, 3800RPM $22.50
Pump Eng Type 1454ME, 24VDC 95A, 4000RPM, 2.25HP $37.50
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Pioneer Autosyn AY-59D1 ..... $12.95
G. E. Selsyn 2JD5SJ31, 60 cy $19.95
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American Blower w/G.E. mtr. 230VAC 50/60cy 1/3HP $14.95
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21F9242G	2	4KV	42.50
14F1	1	5KV	42.50
14F2	1	4KV	37.50
14F216	0.1	4KV	17.50
A7548	1x.25	4KV	17.50
TK48028	1	4KV	17.50
12J7102	2x.275	7.5KV	27.50
7520	2x1.0	7.5KV	27.50
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Inerteen	1.5	10KV	37.50
25F68	0.5	12KV	9.95
TK12006S	1	12.5KV	14.95
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14F18	1	15KV	45.00
14F19	.25	15KV	42.50
14F20	.5	15KV	37.50
19020	.1	20KV	17.50
14F64	.25	20KV	17.50
14F65	.25	20KV	17.50
26F183	.02	20KV	17.50
X5W200	.1	20KV	17.50
26F65	0.5	20KV	45.00
14F72	1.0	20KV	72.50
14F139	.05	20KV	17.50
Inerteen	.1	20KV	17.50
19020	.1	20KV	17.50
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A6734	1.0	20KV	17.50
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1.03	300	1400	3750	18500	1350000
1.3	300	1400	3750	18500	1400000
1.75	316	1488	3768	18250	1450000
2.8	316.5	1500	3800	18800	1470000
3	320	1500	4000	18800	1475000
3.03	325	1510	4030	19000	1500000
4	330	1518	4200	19500	1550000
4.35	340	1600	4250	19800	1600000
5	348	1640	4280	20441	1650000
0.825	350	1650	4300	20500	1667500
6.25	356.6	1650	4300	21000	1670000
6.8	370	1670	4440	21500	1692500
7	375	1680	4444	22000	1750000
7.8	388	1710	4500	22500	1800000
7.9	389	1712	4700	22950	1805000
8	390	1740	4725	23000	1850000
10.38	398	1750	4750	23000	1855000
11.25	410	1800	4850	23125	1900000
12	413	1818	4881	23400	1950000
13.52	416.8	1818	4881	23400	1975000
14.2	425	1850	5000	24000	2010000
14.29	426.9	1865	5100	24750	2050000
14.9	427	1870	5200	25000	2100000
15	430	1894	5215	25200	2150000
16	438	1896	5270	25488	2200000
17	440	1900	5300	25500	2250000
19	452	1957	5400	26000	2275000
19.2	460	1958	5450	26500	2300000
20	470	1958	5450	26500	2350000
22	475	1900	5775	27000	2375000
24	478	1961	5910	27500	2400000
25	487	1963	6100	27500	2450000
26	500	1964	6150	27500	2500000
30	520	1965	6180	27500	2600000
32	526	1966	6300	27500	2700000
32.5	535	1967	6340	27500	2750000
37	538	1900	6400	27500	2800000
38	540	1910	6500	31500	2875000
40	550	1910	6500	31500	2900000
41	575	1911	6500	31500	2950000
51.78	580	1912	6500	31500	3000000
56	583	1913	6500	31500	3100000
56.7	588	1913	7000	31500	3150000
60	612	1915	7700	31500	3200000
63	620	1916	7700	31500	3250000
65	633	1916	7777	38140	3300000
73	633	1918	7900	38500	3325000
74	638	1919	7950	39500	3335000
75	640	1920	7950	39500	3375000
80	642	1923	7950	41400	3500000
81.4	645	1924	7950	41400	3800000
83	645	1926	8000	42000	4000000
84.8	648	1926	8000	42000	4200000
95	657	1900	8250	45000	4220000
100	665	2000	8500	47000	4225000
101	665	2000	8500	47000	4250000
103.2	673	2000	8770	47500	4500000
105	676	2035	9000	48500	4550000
105.7	680	2041	9000	48500	4600000
107	681	2142	9445	50000	4700000
110	684	2145	9500	51000	4720000
118	684	2145	9500	51000	4750000
121.2	697	2160	9500	55000	5000000
125	699	2180	9900	56000	5100000
129	699	2189	9902	56000	5150000
135	711	2195	10000	58333	5210000
147.5	715	2200	10630	60000	5250000
150	720	2200	10630	61430	5400000
160	750	2300	10900	62000	5500000
165	800	2400	10900	64000	5600000
166	800	2400	11000	64000	5700000
175	820	2463	11000	66500	5750000
179	850	2485	11480	66550	6000000
180	850	2488	11480	66550	6200000
182	899	2500	11690	68000	6500000
182.4	900	2525	12000	70000	6540000
200	900	2600	12000	70000	6600000
209.4	917	2625	12800	73500	6800000
210	918	2630	13000	75000	6900000
215	918	2650	13000	75000	6950000
220	1000	2750	13500	82000	7500000
220.4	1030	2850	13550	84000	7613500
225	1050	2860	13640	85000	8000000
230	1059	2870	14000	85750	8130000
235	1067	2900	14250	85000	8200000
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1.2	1.75	2.8	4.25	7.5	12
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1.39	2.11	3.4	5.5	8.62	30
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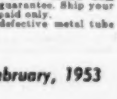

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150 wvdc		1	.79	13000wvdc	
1-1-1-3	.69	1.5	.89	.0010	9.98
2	.35	2	1.19	25000wvdc	
2x.22	.35	15	4.98	.00025	7.49
300wvdc		1400wvdc		1	30.00
1.2	.39	.25	1.29	AC RATED	
400wvdc		.5	1.39	220vac/ 440vdc	
.1	.49	1500wvdc			
.5	.69	.5	1.49	2	.69
1	.69	.75	1.69	4	.89
2	.79	1	1.89	5	1.29
4	1.98	2	2.49	220vac/ 630dc	
6	1.39	6	3.98	3.2	.79
10	1.79	2000wvdc		230vac 630dc	
2x.1	.75	1	1.49	4	1.29
2x.5	.94	2x.1	1.09	8	1.49
2x1	.99	2	1.69	5	3.29
2x.25	.99	3	2.98	330vac 1000dc	
600wvdc		4	3.69	1.25	.69
.024	.39	8	9.49	1.5	.79
.1	.39	2500wvdc		1.75	.99
.25	.39	.25	2.29	4	1.98
.5	.39	3000wvdc		5	2.98
1	.52	1	2.49	8	.98
2	.55	2	4.49	2.5	.98
3	.75	4	7.89	3	1.49
5	2.75	4000wvdc		4	1.29
6	2.89	2	5.98	6	1.49
7	2.89	5000wvdc		10	1.98
10	1.98	2	6.49	16	2.98
2x.1	.59	4	19.98	25	5.49
2x.25	.76	7000wvdc		440vac/ 1200dc	
2x.5	.89	.002	1.69	.15	1.29
2x1	1.05	.0075	1.98	660vac/ 1900dc	
2x2	1.25	.01	2.98	10	6.98
2x3	1.75	7500wvdc		660vac/ 2000dc	
3x.05	.75	.02	2.98	8	4.49
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700wvdc		10000wvdc		16	7.98
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500VCT/60MA, 6.3V/4A HSLD **$2.98**
480VCT/80MA, 6.3VCT/4A, 5V/3A **$2.49**
420VCT/70MA, 6.3V/2A, 6 W/INPUTS 6, 24, 115VDC & 115 230VAC @ **$1.98**
510VCT/150MA, 5V/5A, 6.3V/5A **$3.49**

FILTER CHOKES

Dual 30 Hy/60ma Csd 9.98
15Hy/40ma AC/DC sets, 3 for 1.98
12Hy/80ma/3KVins 2.25
10Hy/75ma 1.25
10Hy/125ma/UTC/Csd/ H'Sld/1KVins 1.49
50Hy/126ma/Csd/H'Sld 2.49
12Hy/300ma/8KVins 4.95
20Hy/300ma or 15Hy/400ma/ 12KVins Kenyon 8.98
13.5Hy 1Amp/17KVins/Raytheon $9.98
Dual 2Hy/300ma USN. **$1.28;** 2 for 2.98

FILAMENT TRANS.

2.5V/2A @ 75c, 2 for **$1.49,** 10 for	$6.49
2.5VCT/10A/12KV INSUL CSD HSLD	7.98
2.5VCT/20A/12KV INSUL CSD HSLD	9.95
5VCT/10A, 4KV INSUL CSD HSLD	6.98
5VCT/10A/12KV INSUL C.S.D.	9.98
5V/60AMP CSD KENYON, HVINS	13.98
5V/125A CSD KENYON HVINS	16.98
6.3VCT/4A 1 KVINS, 2 KVIND HVINS	1.98
6.3VCT/7A NAVY HSLD HVINS	1.98
6.3V/1.5Amp CHANNEL MTG	1.98
6.3V/2Amp CHANNEL MTG	1.98
7.5VCT/1.25A CSD KENYON 15 KVINS	10.98
12.6VCT/1.25A CSD HMSLD	1.98
24V/1.25A CSD @ **$5.98** Two for	9.49
2X12V/2A or **24V/2A @ $3.89** Two for	6.98
42.5V/3A CSD @ **$4.98** Two for	9.49
42.5V/3A SEL RECT TRANS	4.95
INPT 110 & 220 V.. OUTPT 12.6 VCT/ 3.5A, 16.6V/1.25A	6.98

SPEED DRILLS
29 PIECE SET

Chrome Vanadium Speed Steel, machinists or tool makers drills, or for all purpose use. Standard full length 1/16 to 1/2" by 64ths. Wire gauged Black drill index. ..... Delivered Prepaid **$9.98**
12 piece set: 1/16 to 1/2 less drill index. Delivered Prepaid **$5.98**

TUBE CLAMPS

926B-5, 926B-16, 926B, 929-1, 930-19, 926B-19, 926A-10, ... 5 for **$1.00**

"TABS" TUBE SPECIALS

BROKEN KEYS OR CRACKED BASE ELECTRICALLY PERFECT & GTD.
1B3GT, 6H6, 6K6GT, 6SN7GT 12SN7GT ..... **Each 50c; 5 for $2.00**
6BG6G, 6BQ6GT, 12BG7, 19BG6, 6L6G. 6L6GA ..... **Each 75c; 3 for $2.00**

MICROWAVE

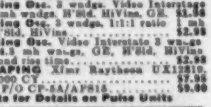
Klystron Mtg Assy (723 AB) & Coupling to 2 Type "N" Co-Ax Fittings **$8.98**
Two for **$15.00**
1 Microsecond Delay Line ..... **$1.98; 4 for $5.00**
Microwave Lighthouse Assy —P/O RT3P APG5 & 15. Less and Tr Cavities, Type N Coupling. Uses 2C43, 2C40, 1B27, Tunes 24-2700 MC Less Tubes. **SPECIAL** ..... **$20.00; 2 for $36.00**

Watt Meter Low Power. Used with Bolometer Bridge Measures Low Level Microwave Power. Balanced Barretter Bridge Direct Reading. Self Calibrating Range 80 Microwatts to 10 Milliwatts. **SPECIAL** **$119.00**
X Band Adapter UG39 to UG40 Choke to Flange ..... **$2.69; 4 for $6.00**

PULSE TRANSFORMERS

PULSE-XFMR 1000 Pulse Per Sec, 5 Watt, TR1025 P/O LU-3 Test Equipment **$7.98**
7.5 KV Pulse, Pri 4 KV, 50-1000 ohm Imped. Formalloy Core. W Enc **$14.98**
Pulse Blocking Osc. 5 wndgs. Video Interstage (1)1 ratio, 20 mh wndgs. H'Sld. HiVins. GE. **$4.98**
Pulse Blocking Osc, 3 wndgs, 1:1:1 ratio 1 mh wndgs GE H'Sld. HiVins **$2.98**
Pulse Blocking Osc. Video Interstage 3 wnd-gs 1:1:1 ratio, 4.5 mh wn-gs, GE, H'Sld. HiVins 1 Micro Second rise time **$2.98**
PULSE SNAPPING Xfmr Raytheon DX1170. 1 MU Sec. 2000 CT **$7.98**
UTAH 9240 P/O CP-8A/APS15 ..... **$9.00**
Write for Details on Pulse Units

MICA CAPACITORS



Brand NEW Made to Rigid Gov't Specs.

Fig. B. .001 mf. 10c. .006 mf. 23c; .01 mf. 25c
Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	600 WV	Each
.0001		$0.29
.001		.42
.002		.46
.003		.46
.004		.46
.005		.49
.006		.49
.008		.49
.01		.49
.02		.76

Mfd.	1200 WV	Each
.03		1.19

Mfd.	1300 WV	Each
.002		.66
.003		.66
.004		.71
.005		.71
.01		.78

Mfd.	2500 WV	Each
.00047		.89

Fig. D. Screw Term & Mtg.

Mfd.	600 WV	Each
.0001		$0.29
.00055		.37
.00065		.42
.0012		.44
.003		.54
.005		.54
.015		.71
.02		.71
.03		1.19
.033		1.28
.039		1.48
.04		1.69
.05		2.39

Mfd.	1200 WV	Each
.001		.61
.002		.64
.0025		.71
.0068		.78

Mfd.	1200 WV	Each
.01		$0.78
.02		.89
.03		1.09
.033		2.39

Mfd.	2100 WV	Each
.0004		.89
.002		1.09
.0022		1.09
.0024		1.13
.0035		1.19
.0036		1.19
.0043		1.29
.005		1.49
.006		1.49

Mfd.	2500 WV	Each
.001		1.49
.015		2.19

Mfd.	3000 WV	Each
.005		1.49

Fig. E. Upright Xmtg Micas

Mfd.	250 VDC	Each
.05		$0.47
.02		2.59

Mfd.	1500 VDC	Each
.04		.89
.05		1.98

Mfd.	2000 VDC	Each
.003		1.08
.008		1.19
.006		1.19
.01		1.39
.015		1.68
.02		1.98
.03		2.35

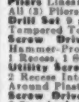
Mfd.	2500 VDC	Each
.0025		1.08
.006		1.45

Mfd.	3000 VDC	Each
.00065		.78

Mfd.	3500 VDC	Each
.00033		.78

Mfd.	5000 VDC	Each
.000082		1.45
.0001		1.79
.00012		1.79
.00015		2.39
.00018		2.39
.0003		2.75
.0043		3.49
.0045		4.79

METER SPECIALS



0-30VDC Aircraft Type "AN" Illustrated ..... **$1.98; 3 for $5.25**
0-25MA DC Weston **$6.98**
0-60ADC "AN" ..... **$3.25; 3 for $9.**
0-200ADC "AN" **$3.49; 1for $9.75**
– 20 + 3VU Weston 201 Vol. Level Indicator **$36.98**

BENCH TOOLS

Pliers 6" Long Nose & Side Cutters	$.89
Pliers 6" Side Cutters	.89
Pliers Linemans 7" Heavy Duty	2.49
All (3) Pliers Listed Above	2.25
Drill Set 9 pcs. 1/16" to 1/4" Hardened & Tempered Tool Steel. Plastic Case. **39c; 3 for $1.**	
Screw Driver Set 6 pcs. magnetized. Hammer-Proof Plastic Handle, 4 Standard, 2 Recess 1 Stubby. **SPECIAL**	.98
Interlocking Screw Driver Set. 3 Standard, & 2 Recess Interchangeable Blades. W/Wrap Around Plastic Case. **SPECIAL**	.79
Screw Driver Set 6 pcs. Plastic handle, 3 Standard, 1 Recess, 1 Stubby, 1 Pocket	.89
4 in 1 Screw Driver Set, blades fit in handle	.89
Offset Screw Driver Standard & Recess	.19
Quick Return Spiral Screw Driver & Drill, with 3 Drill Bits & 1 Sd Blade. **SPECIAL**	2.25

VARIABLE CONDENSERS

RU5 Dual 75mf ea. Sect 1000V Cmp. HF **1.10**
JOHNSON 70M30 70mmf/3kv Gap. **1.29**
Cardwell Next 2T/12 mmf 500 Volt **$4c**
CARDWELL TK-300-US 5S to 312 mmf. Can be made Split Stator. BRAND NEW **$0.98**
Vernier Drive 10 to 360mmf, each **$2.98**
Midget 2 to 15 mmf, Midline, each **49c**
2½ Meter Butterfly Cndsr 30mmf w/RF Tank & Choke ..... **99c; 2 for 98c**

TELEVISION ANTENNAS

Conical antenna, sturdy prefab const. Versatile 72, 150 or 300 ohm match. 8 elements & 100 ft of all copper twines, cross bar and hardware **$5.95**
Double Vee all channel antenna. Hvy duty aluminum construction. Inclds mounting clamp & 100 ft of twines **$4.50**
Window Antenna 4 element conical, all channel, sturdy construction. Easy to mount **$3.95**

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Money Back Guarantee (Cost of Mdse. Only) on Mis. Order FOB NYC. Add. Sphr. Charges & 25% Dep. Tubes Gtd via R-Exp. only. Prices Subject to Change Without Notice.

SELENIUM RECTIFIERS

We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current	18/14 Volts	26/18 Volts	36/26 Volts	54/40 Volts	130/100 Volts
.6 Amp	1.35		2.15	3.70	7.50
1 Amp	1.75		2.75	4.50	10.50
1/4 Amp	1.75		6.75	10.25	
3 Amp	4.25		7.95	12.95	25.25
6 Amp	7.75	9.95	12.95	20.00	40.00
12 Amp	8.50		16.25	28.50	49.00
20 Amp	11.25	16.20	25.50	39.00	75.00
30 Amp	16.50		35.00	45.00	95.00
40 Amp	20.00	24.30	38.50		
75 Amp	35.00		48.50		

Full Wave Selen Rect & Trans. in Kit Form. All 115V/60cy inputs.

up to 14VDC at 12 amps.....$16.00
up to 28VDC at 12 amps.....$16.00
up to 28VDC at 48 amps.....$17.00
up to *20VDC at 5 amps.....$2.95

RECTIFIER XFMRS

14.5—19.2—20.4—21.4 Volts/12 Amp....$10.98
11—12—14—15 Volts/12 Amp 2 Wdgs.....12.95
11—12—14—CT—5—12—15V/4 Amp.....8.75
18—24—1—CT—5—12—18V/12 Amp.....16.75
18VCT—24V—36V/2A—Amp.....15.75
18V/2A.....2.75; 18V/4A.....3.99

BATTERY CHARGER RECTIFIER

10-0-10 Volts (CT) 120 Amp (Fan Cooled). Restores Your Old Inefficient Sulphide Rect. with the New Selenium Types. SPECIAL.....$13.75

RECTIFIER CHOKES

4 Amp	.07 Hy	.4 Ohm	$7.95
12 Amp	.05 Hy	.1 Ohm	14.95
24 Amp	.025 Hy	.025 Ohm	29.95

SHARPENING STONE

INDISPENSABLE for Lab or Workshop. Finest Silicon Carbide. No. 75S Carborundum Co. Unsurpassed for Precision Grinding of Crystals

Kaiser, Fine Tools—6" x ¾".....45c; 3 for $1.00

"TAB" THAT'S A BUY

400 CYCLE XFMRS

G-E/M7472401P1 $140, 5020, 2920, 2810V/ 15" Ht.....$4.98
WE K50606 .288vct/880Ma, 1140vct/70Ma 5.95
G-E/M7472442P1 78V/200Ma, 210V/15Ma, 5V/2A.....4.95
G-E/M7472460 6.3V/7A, 6.7V/6A, 6.3V//.3A 1.98
WE K50604 6.3V/4.5A, 6.3V//.3A.....3.49
WE K50603 6.3V/3A, 5V/2A.....2.98
WE D165412 6.3V/3A.....1.95
LANGEVIN 702586 6.3V/6A.....4.98
FREED 11686 5V/10A.....4.98
WE K50602 5V/6A.....2.98
FREED 11685 2.5vct/10A CSD.....4.95
LANGEVIN 702720 5V/6A, 12 KVINS.....4.98
WED 164513 6.3V//1.25A, 6.3V//1.25A.....1.98

AUDIO COMPONENTS

Western Electric Push-Pull Pentode Output Transformer 107A. Rated 10 Watts for 6V6's or 6AQ5's. Excellent Freq. Response Flat 30 to 15,000 Cycles. Secondary 600 Ohm.....$7.95
"TAB" Special $4.49!....2 for $7.98
With UTC Vatimatch.....$5.49
UTC Varimatch 600 Ohm input Voice Coil.....$1.98
XFMR HMT-5LD UTC Super Electric 2 Wdg. 600 Ohm CT, 600 Tapped 250 & 150 Ohm Can be Used Mike to Grid. Line to Line & Line to Grid.
Special Buy.....10 for $4.49; 100 for $25.00

CIRCULAR SLIDE RULE

Equiv to 12"—Only 2½" Radius. LAMINATED —Print Stays On! Mult., Div., Sqs., Cubes & Roots, Log, Decimal Equiv Data, Case.....98c
Parallel Rules. Precision Drafting Tool 8½" x 11" Sliding 6" rule. For Radiomen, Engineers, Students. Unsurpassed for Quick Ckt Diagrams. SPECIAL.....39c; 3 for $1.00
Ball Pens Red & Blue Grip.....5 for $1.00
Ball Pens Draftsman Black Grip.....2 for $1.00

CIRCUIT BREAKER FUSES

PUSH TO RESET

Amps 1-5-7-10-15-20 Ea. 27c
6 for $1.; 25 for $4.; 100 for $15.
Circuit Breaker Fuse W/2 Mounting Clips 39c; 2 for....$1.00; 20 for....$8.95; 100 for....$35.
Fuse in 3AG Size. Operates up to 24 Volts. Please State Amps (current) desired.
Heinemann Magn Bkrs, Amps: 0.22, 2, 3, 5, 7, 9, 12, 15, 20, 30, 35, 40, 50, 130.....Each $2.69; 10 for $25.98

TEST CORDS

15 Foot Extension Cord Hv Duty, Rubber Covered Insulation. As Illus.....$1.10
6 Foot Line Cord W/Plug Rubber Covered....49c
4 Foot Test Cord. Plug & (3) Alligator Clips Attached.....89c; 2 for 98c
4 Foot Instrument Test Leads. High Quality Red & Black.....89c; 2 for 98c

KITS AND COMPONENTS

SPRGE CRP 3 Vert Integrator Netwk 3 Res-3CNDSR only 3 LEADS 29c. 5 for $1.00
DISC CERAMIC 2X.004MFD/600V 6 for $1.00
50 PWR Magnifier & Condsr. 69c. 4 for 2.00
Silver & Mica Cndsrs.....30 for 2.50
Controls, 50 ohm to 2 Meg.....10 for 2.50
Resistors, ½ & 1W, to 5 Megs.....100 for 2.50
Vitreous WW Resistors.....5 for .49
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Iron Core Slug & Screw.....100 for 2.50
Knobs, Asstd. w/Insert.....10 for .98

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"HO" RAIL PACK

0 to 12VDC/2 Amp Variable DC supply, uncased and completely built —Input. 115v/60 cy. Usable LAB supply, filament D.C. plating, battery charging, model railroad. Includes voltage or speed control and center off reversing sw. Ideal for two "HO" locomotives.....$18.95

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6 Volt WILLARD Mini-BRAND NEW. 8 oz Designed Portable Equip, Models....98c; 4 for $3
(4) 2½V BATTERIES w/Acid.....3.95
2V 20AH Willard PLUS 2V. Vibrator.....2.98
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6V/6AH Willd NT6/BB314U.....2.49
6V/6AH Batt. W/Acid.....2.49
6V/40AH Willard.....6.98
6V/40AH Batt. W/Acid.....7.95
Hydrometer 1.06 to 1.24 Sp Grav. USN.....1.98
Spec Grav Ind & Merc. Thermom.....98
Acid is Shipped in Bottles. R'Exp only

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25 MMF 7.5KV.....$4.98
50 MMF 7.5KV.....
100 MMF 20KV.....19.95
100 MMF 7.5KV.....5.98
12 MMF 20KV.....9.98
50 MMF 20KV.....12.98
13 MMF 32KV.....14.98

CONNECTOR AND CABLES

PL259/SO239 Receptacle.....$0.50
10 for $3.98
PL259PN/PL259A Plug.....$0.45
10 for $3.98
PL259P/PL259 Plug $0.50;10 for 4.75
PL-171/PL258 Junction.....
PL-17/M358.....$1.25; 10 for $11.00
CORD CD5807A...W/JK26 & PL55 5 ft long..1.98
CORD Same as above 5 ft $1.29; 12 ft long..1.49
CORD RG8U COAXIAL CABLE per ft.....12
RG59U Cable per ft 50.00.....100 ft $3.98
300 Ohm All Copper TV Twinex Durable Hvy Wob.....100 ft $1.49; 1000 ft $12.49

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"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE

Use Your Priority for SPEEDY DELIVERY—Extend Your DO & Confirm! Now

6AQ5	$0.98	2E26/HY65	5.35	6A3	1.98	6SF5	.77	12AZ7	1.49	35B5	.79	117Z7GT	1.49	CK537AX	3.04
6AU6/VR75	1.04	2E30	2.98	6A4	1.98	6SP7	.72	12BA6	.69	35C5	.69	12AT6A	1.98	CK538DX	
6AV6	1.04	2E35	2.98	6A5	.88	6SQ7	.72	12BA7	.79	35L6GT	.79	T12S	12.49	CK539DX	2.19
6AX5	.77	2E36	2.98	6A6	.88	6ST7	.72	12BD6	1.23	35T	6.98	FJ27A	19.98	CK541DX	1.99
6B4	1.49	2E42	1.49	6A7	.88	6SU7	.78	12BE6	.69	35TG	6.98	VT127A	3.98	CK542DX	.98
6B6/VR105	1.19	2E41	2.98	6A8	.88	6SU7GT	.69	12BF6	.68	35W4	.69	CV148	4.98	CK543DX	.98
6B8/VR150	.98	2E42	1.49	6AB4	.79	6SY7	1.49	12BH7	1.29	35Y4	.69	150T	14.50	CK544DX	.98
6Y4	2.53	2E42	1.49	6AB5/6N5	1.31	6T7G	.69	12BH7	.77	35Z3	.79	FG105	49.50	CK546DX	1.98
6Z4	1.49	2E43	1.49	6AC7/1852	1.98	6T8	1.26	12BZ7	1.25	35Z4GT	.69	FG172	29.00	CK547DX	1.98
6C4	.88	2G21	1.98	6AC7W	1.98	6T8GT	.63	12C8	.65	35Z5GT	.69	182B	1.20	550P	19.95
6C4-X	2.25	2J21A	5.50	6AC7WGT	2.25	6U7	.69	12CU6	.69	36	.69	FG219Q	12.00	CK571AX/	
6C5	.77	2J22	2.98	6AD7G	1.98	6U7GT	.75	12H6	.65	37	.69	HF200	21.00	5886	2.49
6C5GT	.69	2J26	2.98	6AE5	.88	6U7GTY	2.00	12J5GT	.69	38	.69	T200	22.98	CK573AX/	
6C6	.77	2J27	37.98	6AF4	14.25	6V6	1.09	12K7GT	.69	38HE	.69	2D21A/CK381A		6020	2.49
6C8G	.77	2J30	44.00	6AG5	1.98	6V6GT	1.09	12K8	.69	39/44	2.89	203A	5.98	575A/975	13.75
6D6	.69	2J31	37.98	6AG7	1.98	6W4GT	.67	12K8GT	.69	41	.69	205B/VT2	1.69	WL575	16.49
6E5	.88	2J32	37.98	6AG7/1852	1.98	6W6GT	.89	12Q7GT	.69	42	.79	CNC40	1.59	WL579B	12.98
6E6	.88	2J33	37.98	6AH6	2.98	6X4	.69	12Q7GTA	.69	43	.69	T40	4.29	211/VT4C	4.95
6F4	2.98	2J34	37.98	6AK5	1.98	6X5	.69	12SA7GT	.69	44	.69	TZ40	1.98	CE215	9.98
6F5	.75	2J36	106.00	6AK5W	2.98	6X5GT	.69	12SC7	.69	45	.69	46	1.98	HY615	.25
6F5GT	.75	2J38	11.75	6AK6	1.98	6X8	.89	12SF7GT	.72	HY40Z	1.75	WE215A	4.95	616	37.98
6F6	.88	2J39	11.75	6AL5	.69	6Y6G	1.39	12SF7GT	.69	41	.79	217C	8.75	KU627	18.98
6F6GT	.79	2J40	44.00	6AL7GT	1.25	6Y6GT	1.39	12SH7	.63	42	.69	218C	8.75	WL632	65.00
6F7	.88	2J41	44.00	6AN5	2.98	6Z4	1.09	12SH7GT	.63	43	.69	221A	4.98	WL648A	15.95
6F8G	1.20	2J42	44.00	6AQ5	.98	6Z4GT	.87	12SJ7GT	.69	45Z3	.69	221B	5.98	WL675	117.00
6G5	.88	2K25	39.95	6AQ5GT	.98	6Z4GT	.87	12SK7	.69	45Z5	.69	242C	3.95	WL676	39.95
6G6G	.88	2K26/723AB	5.95	6AQ6	1.98	6W7G	.89	12SL7GT	.69	45Z5GT	.69	247A	9.98	WL686	15.00
6G8G	.88	2K27	110.00	6AS5	1.98	6X2	.89	12SN7GT	.75	46	.69	247A	9.98	701A	5.00
6H6	.49	2K28	110.00	6AS6	1.98	6X3	.89	12SQ7GT	.69	47	.69	250B	9.98	702A	3.25
6H6GT	.49	2K29	110.00	6AS7G	2.98	6X4	.89	12SR7	.69	48	.99	250TH	29.00	703B	5.98
6J4	171.00	2K41	145.00	6AT6	1.98	6X5	.89	12V3	.98	48	1.17	254B	17.75	704A	9.98
6J5	.88	2K42	145.00	6AU5GT	1.98	6Y6G	.89	12X4	.98	RK48A	1.98	HK254	14.49	704A	.98
6J5GT	.79	2K43	145.00	6AU6	1.98	6Z7G	.89	12Z3	.98	RK49A	1.98	255A	5.98	705A/8025	1.98
6J6	.88	2K45	145.00	6AV5GT	1.98	6Z7G	.89	14A4	.89	RK49	7.50	274B	5.98	706A	1.98
6J6A	1.75	2K46	145.00	6AV6	.79	6Z7YIG	.89	14A5	.89	49	.63	276A	9.89	707B	13.50
6K6GT	.79	2K47	145.00	6AX5GT	.79	7A4/XXL	.73	14A7/12BY7	.79	50	.63	304TH	29.00	710A/8013	.98
6K7	.88	2K48	110.00	6B4G	1.19	7A5	.73	14AF7/XXD	.79	50A5	1.19	T300	22.98	715A	
6K7GT	.79	2K49	110.00	6B6G	.98	7A6	.73	14B6	.68	50A5	1.19	T300	22.98	715A	

6K8	.79	2V3G	.79	6B7	.88	7A7	.69	14B8	.85	50B5	.79	HF300	24.30	NL714	5.95
6K8G	.79	2W3GT	.79	6B8	.88	7A8	.69	14C5	1.07	50C5	.69	304TH	8.98	714AY	5.98
6L6	.88	2X2A	1.49	6B8G	.79	7AD7	1.49	14C7	.95	50C6	1.49	304TH	8.98	715A	6.00
6L6G	.88	2X2A	1.49	6BA6	.79	7AF7	.79	14E7	.98	50L6GT	.79	307A/RK75	6.98	715B	6.00
6L6GT	.79	3A4	1.49	6BA7	.79	7AG7	1.98	14F5	1.09	50X6	.89	310A	6.25	715C	19.00
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6L7G	.88	3A5	1.98	6BC7	.79	7B6	.73	14G7	.98	50YGT	.79	311CT	10.98	718BY	48.41
6M5	.88	3B22/RK22	4.49	6BD5	.79	7B7	.73	14H7	.83	51	.69	311T	10.50	718CY	48.41
6N5G	.88	3B24	7.98	6BE5	.79	7B8	.73	14J7	.83	52	.69	313C	2.98	719A	28.50
6N6G	.88	3B25	7.98	6BE6	.79	7C4	.73	14N7	.80	53	.69	316A	1.49	721A	2.98
6N7	.88	3B26	7.98	6BF5	.79	7C5	.69	14Q7	.71	55	1.06	323A	24.25	721B	12.50
6N7G	.88	3B27	7.98	6BF6	.79	7C6	.69	14W7	1.09	56	.79	327A	4.95	722A/237	2.45
6N7GT	.79	3C21	7.98	6BG6G	2.98	7C7	.69	14X7	1.23	RK59	1.48	350B	4.95	724A	2.98
6P5GT	.79	3C21/C1B	7.98	6BG6GT	2.98	7C8	.69	14Y7	1.23	RK60/1642	1.98	HK354	24.98	725A	8.49
6P9	.79	3C21/XXB	7.98	6BH6	.79	7C9	72.00	15A	.89	RK61	3.95	350A	14.25	726A	14.25
6P9GT	.79	3C22	77.00	6BJ6	.79	7CB6	69.96	15R	.89	RK62	3.98	371B	7.98	726B	14.25
6Q7	.88	3C24/HK24	5.49	6BK5	.79	7E5/1201	.65	FG17	3.98	TY40	1.98	371C	.98	726C	52.00
6Q7G	.88	3C45	15.49	6BL7GT	1.49	7E6	.73	19	.98	HY69	.49	372A	.98	800	1.85
6Q7GT	.79	3D6/1299	.79	6BN6	.79	7E7	.73	19BG6G	1.79	70A7	1.98	380A	.98	801A	.98
6R7	.88	3D21A	4.98	6BQ5	.79	7E8	.73	19T8	1.79	70L7GT	1.49	388A	1.98	802	1.69
6R7G	.88	3D22	13.98	6BQ6GT	1.98	7F7	.73	19TP26	1.79	71A	.79	393A	4.98	803	3.98
6S7	.88	3E29	14.95	6BQ7	1.62	7G7/1252	.89	19V8	1.62	72	.79	394A	4.98	805	3.98
6S7G	.88	3E29	14.95	6BR5	1.98	7H7	.73	T20/1629	1.79	CRP72	1.20	450TH	29.00	807	1.98
6SA7	.88	3GP1	110.00	6BR7	1.98	7J7	.73	TUP20	1.79	CRP73	1.49	700	1.98	808	2.59
6SA7GT	.79	3HP1	110.00	6BS7	1.98	7K7	1.10	TZ20	1.79	73	1.67	WE417/5842	10.50	809	2.45
6SB7Y	.88	3J24	110.00	6BT5	1.98	7L7	.83	20	1.17	NR74	.29	WL417A	8.95	810	2.43
6SC7	.79	3K8	300.00	6BU8	1.98	7N7	.73	20P1	1.98	HY75	4.98	GL-434A	18.50	811	2.98
6SC7GT	.72	3LF4	1.29	6BW6	1.98	7Q7	.69	20P3	1.98	76	.99	446A	1.05	811A	2.90
6SD7GT	.72	3Q4	.98	6BX6	1.98	7R7	.83	21	.98	76	.69	446B	1.05	811A	2.70
6SF5	.77	12AZ7	1.49	6BZ6	.79	7S7	.83	22	.98	77	.69	450TH	45.00	812	2.70

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12AT6	.72	30	.69	VU111	1.98	CK529AX	1.79	849	19.98	9014A	28.95
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12AV7	.98	32L7GT	1.49	117N7GT	1.79	CK532DX	1.89	865	1.29	9002	.95
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12AX7	.79	35/51	.89	117Z4GT	1.39	CK536AX	.99	872A	3.29	9006	.39
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935	.39	3GP1	16.50								
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946	.36	3HP7	18.00								
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957/FG17	.98	3JP1	12.98								
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991	.49	3JP14	16.95								
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CK1007	.80	5BP4	4.25								
CK1027	2.50	5CP1	4.50								
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CK1059	2.99	5CP7	12.75								
CK1060	2.69	5DP7	12.75								
R1100	.80	5FP7	1.49								
R1130	12.00	5HP1	5.70								
R1131	2.69	5JP4	5.70								
HY1251Z	1.35	5JP2	19.25								
1612	1.98	5JP4	26.75								
1613	.74	5JP4	26.75								
1614	.74	5JP7A	39.00								
1615	.25	5LP1	22.25								
1621	.25	5LP2	27.50								
1622	2.69	5LP7	29.95								
1624	1.98	5LP4A	33.00								
1625	.25	5RP1	49.50								
1626	.33	5RP7A	89.50								
1629	.25	7BP1	8.65								
1630	.25	7BP7	8.65								
1631	.74	7EP4	17.98								
1632	.77	7JP4	18.39								
1633	.73	7JP7	18.39								
1634	.73	9LP7	2.98								
1635	1.35	12DP7	16.49								
1636	1.35	12DP7A	49.50								
1638	.95	12GP1	49.98								
2000T	149.50	12GP7	14.75								
2051	1.49	20HP7	14.75								
2052	1.15	905	1.98								
5516	1.98	912	89.98								
5517	1.98	913	89.98								
5594	6.65	914A	45.00								
5668A	5.95										
5670	1.98	Xtal Diodes									
5671	12.64	1N21	.98								
5647	5.25	1N21A	1.85								
5651	2.75	1N21B	2.35								
5654	2.75	1N21C	21.50								
5656	6.50	1N22	1.25								
CK5672	1.98	1N23	1.25								
5663	1.98	1N23A	2.35								
5670	5.50	1N23B	3.49								
CK5672	1.98	1N25	1.25								
CK5678	1.98	1N27	1.50								
5679	14.50	1N29	1.50								
5686	1.98	1N32	23.75								
5687	5.49	1N34	.84								
5694	5.49	1N34A	.98								
CK5697	1.49	1N35	1.45								
CK5702	1.49	1N38	1.43								
CK5703	1.49	1N38A	1.19								
CK5704	1.89	1N40	7.35								
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5719	12.75	1N41	1.98								
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GL5727	4.49	1N42	17.50								
5744		1N44	1.98								
CK619CX	1.49	1N46	1.21								
5749	1.98	1N45	1.39								
5751	5.95	1N47	.98								
5754	1.98	1N47	5.49								
CK5783	6.69	1N48	.59								
CK5784	6.98	1N52	.98								
5811	11.25	1N53	1.62								
5814	3.64	1N54	2.35								
CK5829	4.45	1N55	2.35								
5843	12.15	1N55A	3.89								
CK5851	7.75	1N56	.89								
CK5875	1.69	1N58	1.19								
5876	1.98	1N58A	1.39								
X6030	4.45	1N58A	1.49								
8002W	99.50	1N60	.98								
8008	4.75	1N62	2.10								
8008	6.45	1N63/K63	2.49								
8012	2.89	1N67	.98								
8013	2.73	1N67	1.35								
8013A	6.45	1N69	1.98								
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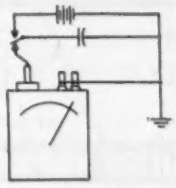
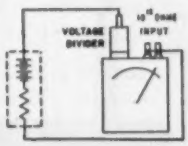
Here is an exceptionally versatile dc voltmeter, and a few of its many uses. The Keithley Instruments Model 200 Electrometer has an input resistance of over 10^{14} ohms shunted by 6 mmf; 2 and 20 volt scales, with input currents of 5×10^{-14} and 5×10^{-13} ampere respectively. Accuracy is within 2% full scale, or within 5% of the reading at low values.

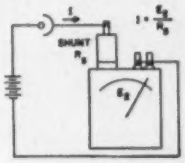


EXCEPTIONALLY FAST WAY to check capacitor leakage—by direct measurement of voltage decay. Also easily measured: piezoelectric potentials, vacuum tube electrode potentials, electrostatic fields.

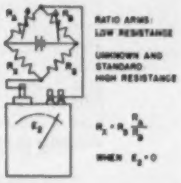
POTENTIALS OVER 20 VOLTS—Model 2002 Voltage Divider has 100: 1 ratio, clips over guard ring of HI terminal. Thus, dc circuit potentials up to 500 volts, such as the open circuit voltage of this high impedance source, are read directly.



CURRENTS AS LOW AS 10^{-14} ampere are measured directly with Model 2001 Electrometer shunts. Available with resistances from 1.0×10^6 up to 1.0×10^{13} ohms. Typical uses: photocell currents (shown), ion chambers, capacitor and insulation leakages.



RESISTANCES UP TO 10^{16} **OHMS** are easily measured with Wheatstone Bridge circuit diagramed, or by measuring current resulting from known applied voltage. Typical uses include standardizing resistors, measuring insulation samples.



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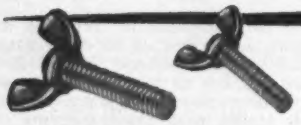

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Die cast, not headed! Closer tolerances, more uniform heads for greater riveting efficiency. Dia. up to 9/64"; lengths to 5/16".

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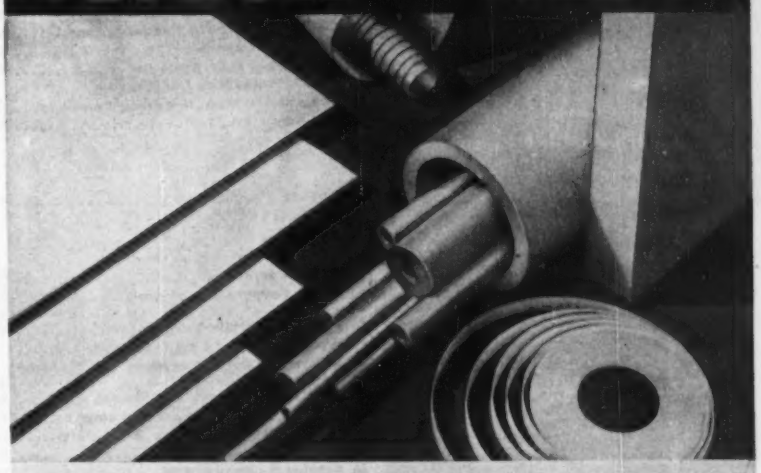

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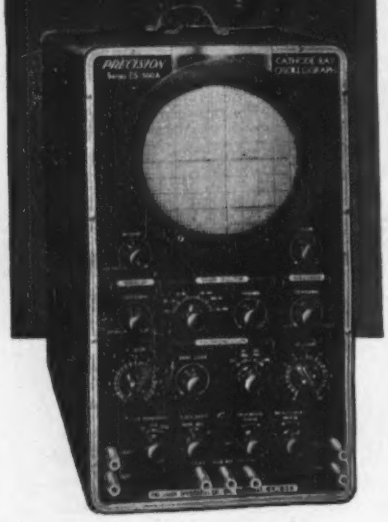

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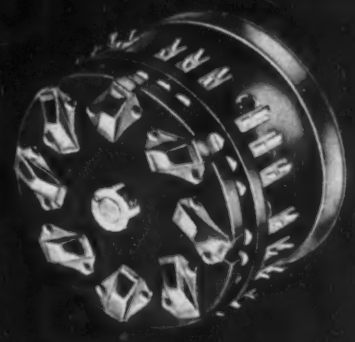

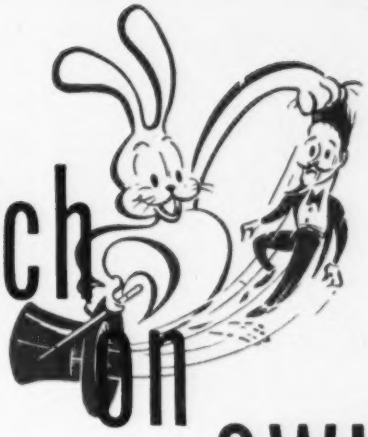

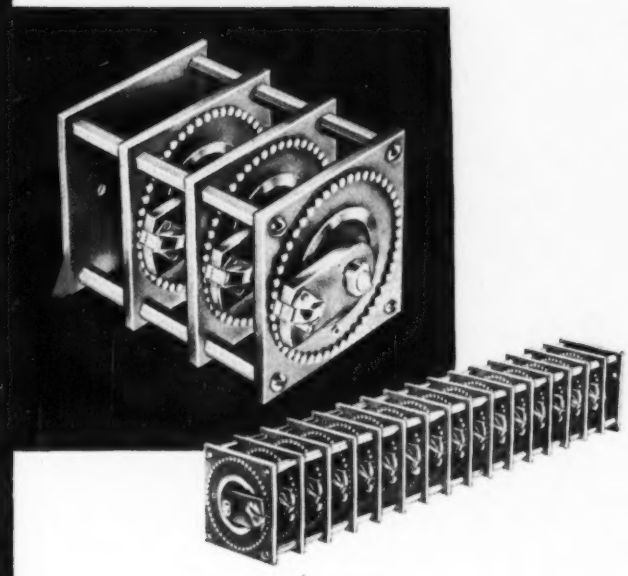

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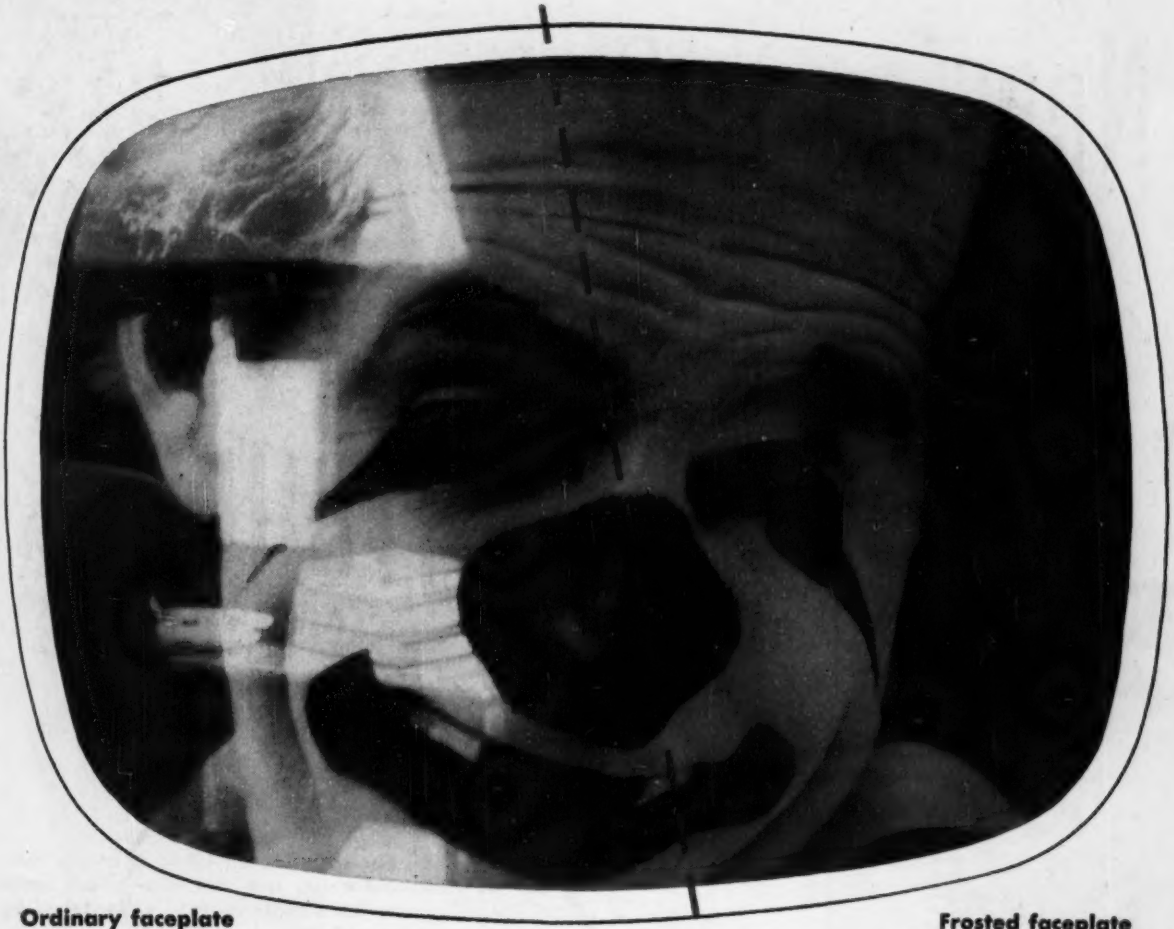

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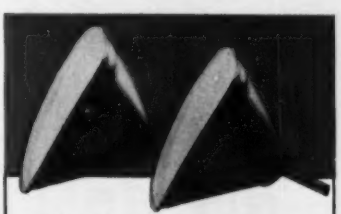

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